ARITHMETIC IN ACTION

E. BRIDEOAKE
and I. D. GROVES

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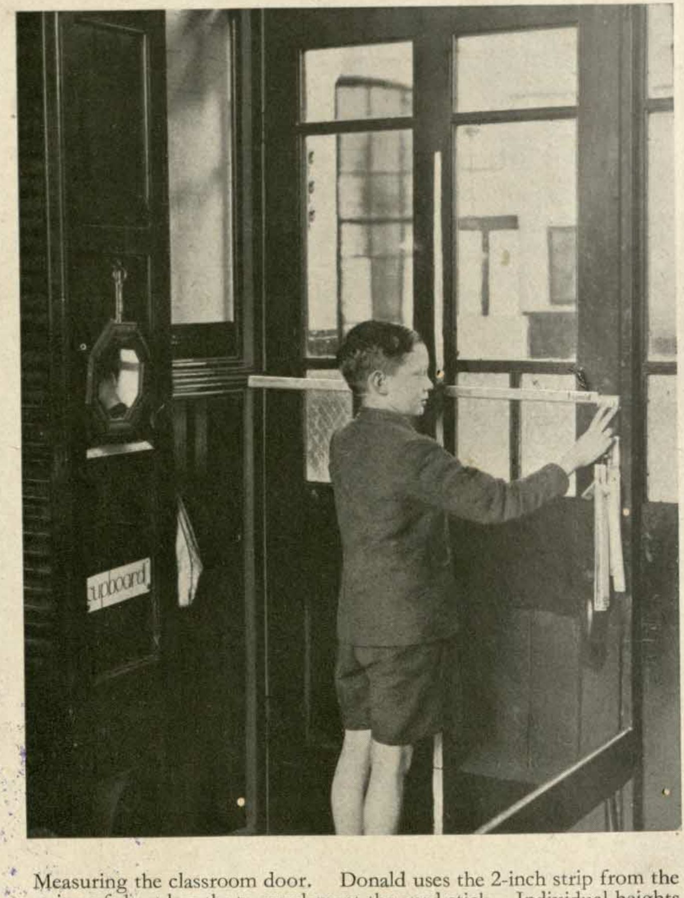

Measuring the classroom door. Donald uses the 2-inch strip from the string of short lengths to supplement the yard stick. Individual heights are measured by the upright white line.

[*Frontispiece*

ARITHMETIC IN ACTION

A PRACTICAL APPROACH TO INFANT NUMBER WORK

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PREFACE

This book is the outline of a scheme designed to link Number teaching with everyday transactions, and so to supply the children with those experiences which lead to a real comprehension of Number.

We felt that in the past, many children who failed to achieve success in "sum lessons" showed considerable grasp of the subject when shopping in the High Street or taking the milk. They were not devoid of number sense, but the school approach was faulty.

Accordingly we experimented with a scheme which brought into the classroom some of the numerical activities which are found in the daily life of the people, and have been amply rewarded by the response of the children.

It *was* an experiment, but thanks to the co-operation of the teaching staffs and the encouraging and constructive criticism of those who have watched its development, we feel it has now passed to the stage of being (for us, at least) a permanent system, and as such we would pass on to our colleagues this description of our venture.

BIRMINGHAM,
February, 1939.

E. BRIDEOAKE.
I. D. GROVES.

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CHAPTER I

A NEW APPROACH TO INFANT NUMBER TEACHING

TWENTY years ago, " Arithmetic " figured in the Infant time-table. Now it is called " Number." Why has there been this change?

The answer to this question is, broadly speaking, found in the modern change in outlook on the subject.

In the earlier period it was " sums " which mattered. *Class teaching* was the method, with its visualising and memorising, and the ideal was that the children should learn the four rules and be able to get the daily " six sums " right.

Then a reaction in favour of *individual work* set in. This was led by the great educationist, Madame Montessori, and resulted in a flood of " number apparatus," extensive exercises in counting, and pretentious written sums; but still there was, very often, little mental alertness or real number power.

Now many teachers are feeling their way to a *realistic approach*, with its underlying idea that development of the number sense is what matters, and that " sums " are only the expression of this.

Working in this way, we try to discover how a child obtained his first knowledge of number (which was his long before he came to school).

Investigation shows that he gained these number notions by doing what interested him in his home. He knew when there were " few " or " many " birds on the bird table, he collected the tickets he and mother had on the bus, and he learnt the relative sizes of socks on the line on washing-day. This interest, followed by experience, resulted in a knowledge of number which was real to him, and it is along these lines that modern methods of Number teaching tend to progress.

On this basis, the order of a child's progress should be :

(*a*) Experience and Language before Comprehension.

(*b*) Concrete and Visual before Abstract.

(*c*) Qualitative before Quantitative.

More " C " streams are made by the constant failure to reach a preconceived standard along preconceived lines than by any other means, and the greatest possible antidote to this sense of failure is the self-confidence gained by investigation and experiment—which is an even more important asset than mechanical skill.

With this belief in mind, we have carried out a considerable amount of experimental work in our classes, the result of which convinces us that a realistic approach with its variety of experiences brings an appreciation of number ideas, and in addition exact knowledge and power, which are more permanent and of more use in fresh situations than that obtained in other ways.

Inside one of these classrooms little tongues are loosened and little feet are going to and fro.

"I've bought cocoa; that's fivepence," mutters Mary to herself—a pause while she adds this item to those already on her sheet of paper; then, as she examines her small canvas purse, "Oh, I've no more money, so I'll have to stop."

Six-year-old Mary, sharing her mother's shopping experiences, is one of a class of fifty children who are working on the assumption that an arithmetical *rule* is not of primary importance. The thing that matters is to become aware that there is any *necessity* for a process. So the child does his job, and then describes it, to find ultimately that a rule is a brief and convenient way of describing the sum he has just performed.

As members of the "shopping" group, Mary and three other children work in their classroom at a corner shop, where, with a proper counter and well-stocked shelves, they buy real packets and make out real bills to their hearts' content.

But there are other occupations. At the next table, embryo carpenters and drapers are engaged in measuring lengths of wooden lath or coloured tape. Beryl has just collected some odd pieces of red tape, and is measuring each in turn, and making a careful list of her results. " I've got four inches, and seven inches, and eight inches," she confides in you as you pause by her work. " I think it's nineteen inches, but I'll go and be sure." So she goes to the long tape-measure pinned to the wall, and after placing her lengths along it, returns satisfied. " That's all right. Now I can try the green."

In another group, four children are engaged with scales, some purchased, some begged from kindly shopkeepers and some home-made, but all appreciated by the little people who are discovering that if you want a large bag of sweets for an ounce, you must choose the tiny variety; while Brian is particularly exultant because he has found out that if he wants half a pound of shells, he can use " that big fat weight " instead of the eight separate ounces which so persistently slip off his scale pan.

Above the hum of conversation, occasionally one hears a splash of water and the tinkle of vessels. These sounds come from the next group of children, who are finding out for themselves how many cups of the milky-looking liquid (water coloured with white paint) can be filled from a milk bottle, or which holds the more, the milkman's " pint " bottle or mother's " pint " jug.

At a nearby table, Billy and his three companions have their " buses "—cards on which are drawn plans of bus interiors—and the seats are being filled with tickets, each being paid for as it is placed. At the end of each " trip " the ticket values and money taken are checked.

There are still other activities to be seen in this room. At one table are wooden clocks with movable fingers to solve the mysteries of time-telling; at another halves and quarters are being combined into cakes; and away in a corner, children " snapping " answers to sums are deciding whether the " 7 and 4 " on Nan's card make the " 11 " on George's.

Day by day they change to the other groups, till they have shared in every experience, by which time they are prepared to try fresh experiments with the same medium, so that the work never lacks interest.

No doubt the method is revolutionary, and upsets many carefully preconceived schemes and plans which certainly produced results. But it does foster a process of mental growth engendered by close contact with the material world in which a child will ultimately work.

In the "good old days" there were set lines of approach—no one learned division before he had mastered addition, and there were well-defined "methods" for each rule. Working in the new way, it is more than likely that Enid will practise sharing half a pound of rice among four pudding dishes long before she has worried about how much the large and small dishes take together or how much is left in the bag when she has filled two dishes.

So be prepared to accept results in the order in which they come, and, above all, remember that this method is one of work, not play.

Very often an infant does his best and biggest piece of work when, according to our grown-up ideas, he is playing; so there has developed the conviction, perhaps unexpressed, that if a child likes what he is doing, it is play—if not, it is work. Possibly it is this desire to make school life pleasant through play which is responsible for much of the pretty but futile "apparatus" with which the market is flooded at the present time.

Surely work with a purpose is more fascinating than any amount of mere occupation, and it is in the recognition of this that the teacher plays her part in number work as we have planned it. To measure and weigh, etc., appeal to the child's desire for knowledge and activity, but it must be directed by the teacher to a recognised end. To the child the activity is not consciously purposeful, but *we* must know it is, and grade it accordingly.

CHAPTER II

SCOPE OF INFANT NUMBER WORK

THE national structure of education begins when the child is 5—but we must recognise that these little folk have lived and learned for five long years before they attend school.

Accordingly, when we prepare our Number scheme, it is well to consider anew the two things mentioned in the previous chapter:

(*a*) What number knowledge a child has when he comes to school.

(*b*) How that knowledge was acquired.

As we have already said, when a child enters the Reception Class, and chatters to his teacher of the "*lots*" of flowers in his garden, or, stretching out his arms to their widest extent, shows how big was the castle he made at the seaside, he already has very distinct number conceptions.

This, then, is our starting-point—so the child begins with occupations which bring out the basic ideas of many and few, heavy and light, long and short. Gradually he learns to express his

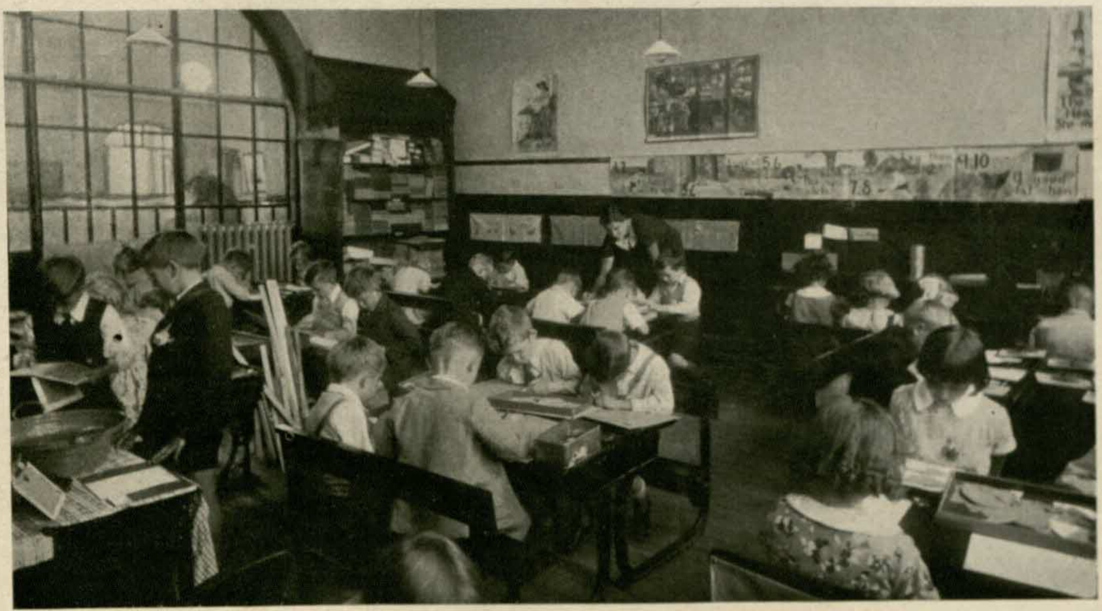


PLATE 1

A class at work. Children on the left are working with fractions. In the centre is a bus group, and on the right capacity is measured. Wall pockets contain exercises.

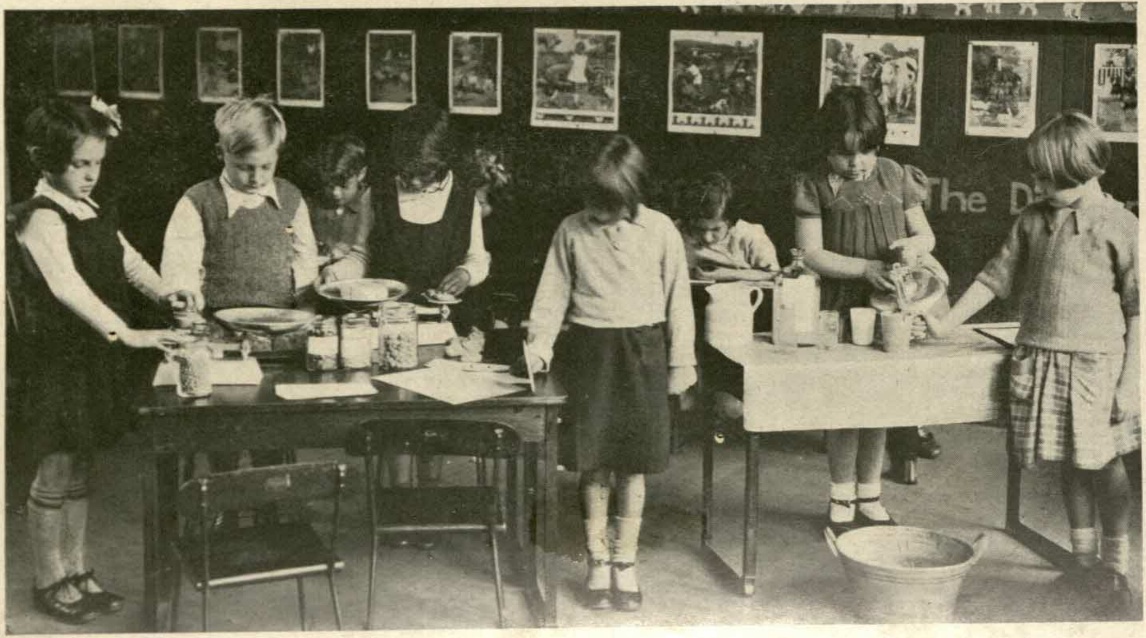


PLATE II

Two groups. While the first weighs parcels, sweets, and groceries, the other finds how many beakers can be filled from the kettle.

increasing knowledge in conventional terms, so that he can use it in intercourse with his fellows.

This knowledge must be gained, as it was in pre-school years, by practical experience, which is clarified, first by the use of apparatus, and secondly, by clear verbal (and later, written) statements, which crystallise facts and lead to a better understanding of problems.

As the child progresses, there are some facts which recur so frequently that it becomes necessary, in the interests of economy in time and effort, for him to know them by heart. They must become part of the mental outfit with which he faces life.

On these principles this scheme of number work is based, and it consists of practical experiences in all activities, balanced by systematic and carefully prepared mental work in notation.

The child *must* learn his figures and the pictures associated therewith. But each new piece of knowledge as it is acquired must be so impressed by his practical experiences that it becomes a living reality, and not a meaningless combination of sounds.

As soon as one of these little folk has learned "2," he can buy 2*d.* worth of sweets, measure 2 units of ribbon, put his beads in 2's, and so on with every activity and each new figure.

In each activity combinations of numbers will occur. These the child is encountering daily in his " mental " work. He may cut off 6 inches of lace, and then 7 inches. How many inches has he? If his mental work has progressed, he knows that 6 and 7 make 13 ; but when he handles " 6 inches " and " 7 inches " and sees " 13 inches " as a definite length, he has passed, by way of the stages of (1) experience, (2) clarification, (3) skill, and (4) application, to the realisation, that to know that " 6 and 7 make 13 " serves a definite purpose in life. His knowledge is no longer merely intellectual. It is deep reality.

The Scheme Outlined

In very bare outline, the following is the scheme in which practical and mental work combine :

1. All numbers up to 10, learnt through concrete material and games.

2. Certain of the number bonds up to 20. The doubles are included in another part of the scheme, so they do not appear here ; the reverse bonds, such as 5 and 7, are left till the Junior School stage, so we choose the sixteen remaining ones, which are : 6 and 5 ; 7 and 4, 5, 6 ; 8 and 3, 4, 5, 6, 7 ; 9 and 2, 3, 4, 5, 6, 7, 8.

3. To progress by 10's, i.e. 2 10's, 3 10's, etc., to 100.

4. To be able to count up to 100, and record by some device the meaning of a number, e.g. 36, so that he has some idea of positional value. Here we prefer the child to make some picture of his own, such as 3 houses with 10 folk in each and 6 in the garden, or 3 baskets with 10 apples in each and 6 on the floor, leaving more conventional representations, such as bead bars, to a later stage.

5. To be able to count in 2's, 4's, 5's, and 10's up to 100.

6. To know the 2, 5, and 10 times tables, and to be able to build up any other tables as he needs them.

7. To be able to combine in a concrete operation any two numbers up to 12, in addition or subtraction (since this latter is only the remainder when addition is carried on beyond one number to a second. A useful illustration of this is the shop-assistant who, when you have spent 9*d.*, says "tenpence, elevenpence, a shilling—threepence change.")

8. To be able to do simple shopping exercises.

9. To know the common units of weight, length, and capacity, also of money and time.

10. To have a simple practical knowledge of ½ and ¼.

To teach such a scheme as pure number is not difficult to any trained teacher, but to consider an

CHAPTER III

FIRST STEPS—THE RECEPTION CLASS

In the area in which these experiments in practical number have been conducted there is no Nursery School. The local regulations allow children to enter school " at the beginning of the term in which they attain the age of 5 years." There are four terms in each school year, so that the minimum age of admission is 4 years and 9 months, but the majority are 5 before they come. Consequently our five-year-olds have no preliminary background, and for the first six months of their school life we endeavour to make the Reception Classroom conditions approximate to those of a Nursery School.

These children use much of the " Montessori " apparatus—the long stair and high tower—and from these receive their first impressions of length, height, weight, etc.

But, in addition, we use simple apparatus which provides a real foundation for the practical arithmetical exercises at which the children are to work at a later date.

1. *Sorting Boxes.* Our first box is reminiscent of " Granny's workbox," and is a collection of very everyday odds and ends—pieces of chalk, pen nibs, paper clips, cotton reels, buttons, and studs.

On his table the child has a tray—we use a "toffee" tin, brightened by a coat of enamel—and into this he sorts his odds and ends, in piles.

We feel it is important that at this very first stage the articles to be sorted should be identical, so we do not include buttons of various sizes, but just one variety of button, one size stud, etc.

2. "*Big and Little.*" The first step in grading is provided by an attractive box of toys, "big and little," dolls, ships, trains, teddy-bears, and trumpets. At the table the teacher draws a chalk-line down the centre, and the child puts his "big" toy on the left-hand side and his "little" one on the right-hand half. As *size* is the purpose of this exercise, we try to provide toys which differ in this only, e.g. both dolls are celluloid.

3. "*Heavy and Light.*" The box containing "heavy" and "light" material is sorted in the same way. The child finds two boxes, exactly alike in appearance, and places the one which is heavy on the left side of his table, while the light one goes to the right. We have found empty cocoa tins, cheese boxes, sweet bottles, as well as cardboard boxes, useful in this section, and when they are filled with varying quantities of sand, the difference in weight is very real.

4. "*Many and Few.*" Here a child is provided with two cards of linen buttons, hooks and eyes, press studs, etc., on one of which are many objects, while the companion card bears few. Similarly, he has two packets of envelopes, postcards, etc., which differ only in the quantity they contain.

While the children are working with their sorting boxes, the teacher moves among the tables and asks the children to show her their " big " toys, their " heavy " boxes, a " few " buttons, etc.

5. "*Long and Short.*" Simple strips again supply the material for this exercise; knitting pins of various lengths are useful, long and short pencils, etc. It is advisable to have length the only difference between the two articles to be sorted.

When the teacher feels that a child has learned the names of his varieties, she changes the form of the question, asking, " What are these ? " and the child gives her the term " little," " many," or " heavy," as the case may be. There is, of course, no set time when this change is made. As the teacher feels that the individual child is making progress, so she helps him to record it verbally to himself.

As we have said before, throughout this scheme the stages in mastery are ; experience, clarification, skill, and application ; the child's expression of this being DO, then SAY, and later, USE SYMBOLS.

Accordingly, at this earliest stage, when a child has gained an experience, he clarifies it by telling us what he has done.

DOMINOES

When the child has had a little experience with the sorting boxes, we introduce him to simple dominoes. The possibilities of this game are almost endless, especially when it is used to help the children to memorise number facts. Many of its uses in this way are described in the "games" chapter, but when used by the Reception Class, its main purpose is to offer further exercises in sorting.

1. *Colour Dominoes*

We find this the most simple form of this game. These dominoes are made of strips of cardboard or plywood, 2½ inches by 1½ inches, on which are pasted papers of different colours, and with these the child plays alone, just matching the colours.

For the very first stages the colours in the packets of kindergarten paper suffice, but when we wish to make them a little harder we find that one of the "Shade cards," which can be begged from a colour merchant, provides a full range of shades and tints.

A large set of colour dominoes made with pieces of cardboard about 6 inches by 3 inches and which can be used by the teacher for demonstration purposes on the classroom floor is a very attractive and popular piece of apparatus.

2. *Picture Dominoes*

A slight advance is the box of picture dominoes, which contains illustrations of common toys, teddy-bears, drums, etc. Again the child plays alone, matching the pictures from end to end.

3. *Playing the Game*

It is a real advance for the five-year-old to learn to wait for his turn, and we make the start with two children sitting at opposite sides of the table, their dominoes placed down the middle.

Before the domino game starts each child takes a domino in turn and it is a useful counting exercise for the children to check their own pile before beginning their game and to make sure that each has the same number of dominoes.

It is interesting to see how the other children are drawn to watch a game in progress, and as " learning from each other " is a principle on which we work throughout the scheme, this is a feature we encourage. The most helpful child, usually, is the one who has just grasped the idea himself, and is ready to show his own skill, as well as to help his neighbour.

JIG-SAWS

Very simple jig-saws are also introduced at this stage, because they are later used as number games. So here the children learn to fit the pieces together to make the picture.

The very earliest puzzles are made by the teacher herself, who mounts simple pictures on cardboard, cutting the first ones into squares only, and using diagonal cuts as a little advance.

Again the child works alone, but should another member of the class offer a little assistance, he is quite at liberty to do so.

NURSERY RHYMES AND FIGURES

As is usual at this stage, the first counting is done in the form of nursery rhymes, and the first introduction to figures is the illustrated nursery rhymes with figures, which most teachers use as wall decoration.

So here we have " One, two, buckle my shoe," and hear the little voices singing " 1, 2, 3, 4, 5, Once I caught a fish alive," etc.

At this stage the repetition is words only. The child has not yet reached the stage of appreciating number as a sequence, but it is a beginning, and therefore one of the stones in the " Foundations."

CHAPTER IV

LENGTH—SCHEMES, APPARATUS, AND EXERCISES

WHEN the children pass from the Reception Class, they begin to apply their ideas of number to the many various types of measurement, such as length, weight, capacity, time, and money.

In every class these activities are taken concurrently, each group working in its own medium, but, for the sake of clarity, we have brought together the stages in each type of measurement, beginning with length.

GRADING AND SORTING

We begin with grading and sorting exercises which continue to develop the basic ideas of " long and short," first discovered in the Reception Class. Children doing these exercises have envelopes containing strips of cardboard, cut into lengths, varying from 1 to 5 inches. There are at least two of each length, so that the child can not only grade them, but can also match the ones which are alike.

These little ones also work with long strips of paper, which we cut into 1-inch widths from a large sheet of cap paper, with a card-cutter or a razor blade. From these lengths they cut off pieces to match the card strips, also cut lengths which they fold into two, and so divide them, or cut off a given piece as often as they can from a long strip.

SHOPPING

When they are accustomed to cutting lengths, the children practise this in the "Ribbon" shop, where lengths of paper which they have painted, and long strips of crinkled paper wound round old film spools, make a colourful display.

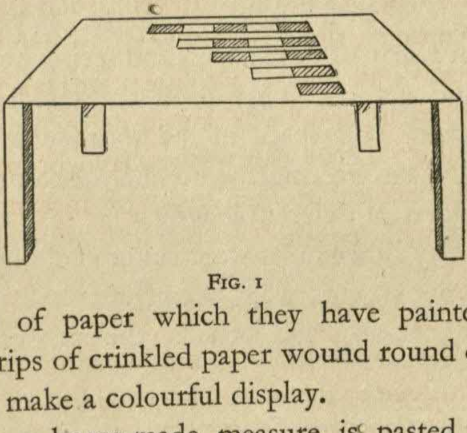


FIG. 1

Here a home-made measure is pasted on the counter. It consists of a coloured "stair," made of gummed-paper lengths. There is no need to have any special length for the first unit. It may be 2 or 3 inches—as the teacher chooses—the only necessity being that this unit is repeated in the steps of the stair. Thus the top step, one unit of red paper, represents one pennyworth of ribbon; the second, two units of red and blue paper, is two pennyworth, and so on, down to the five units, for which fivepence must be paid (Fig. 1).

OTHER UNCONVENTIONAL MEASURES

When the children began to measure in this way, they were introduced to other unconventional measures. We began with "shoes," and on the morning of the introduction, the teacher was found marking out with black crayon the shape of her shoes on a strip of newspaper, and seeing how many she could get in. Very soon the children were filling every odd space in the room with similar strips, and discovering the number of steps needed to fill papers of different lengths.

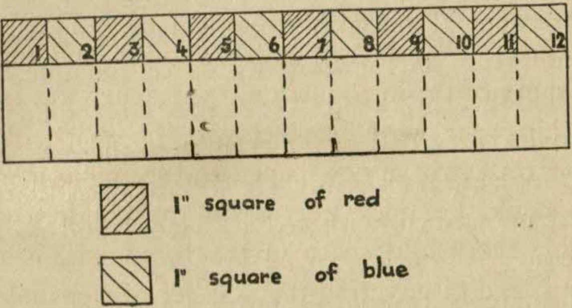
Next day other units were suggested, and desks, boards, floors, etc., were being measured in terms of hands, books, and pencils, the answers being compared.

PROGRESSION TO CONVENTIONAL MEASURES

"If our desk is ten of my pencil and fourteen of Joan's, how can you tell how long it really is?" was an obvious question, so there was a class talk on the use of the conventional "foot," and soon everything was remeasured in terms of a strip of cardboard provided by the teacher, and called a "foot."

HOME-MADE RULERS

Naturally, the children soon found these rulers too long for some of the short things they wanted to measure, so during the next Handwork period the teacher showed them how to make their first ruler, using a strip of white cardboard, 12 inches by 3 inches. Along the top of this they pasted twelve 1-inch pieces of coloured paper, alternating contrasting colours (Fig. 2). The numbers were written close to the joins, and the children were then able to measure a host of smaller things.



Child's Ruler - cardboard with coloured strips.

FIG. 2

CORD ENVELOPES

We found these rulers very useful in connection with the "cord" envelopes. These were foolscap envelopes, containing at least eight lengths of blind cord dyed different colours, and cut in lengths of from 2 inches to 11 inches.

In the same envelope we put eight question cards, with the words "How long is the blue (green, white, etc.) cord?" The colour word is underlined with that colour crayon.

As a general rule, a child at this stage of measuring cannot read the separate words of the question. We find that this does not constitute a real difficulty. He quickly learns that the exercise in that envelope is to measure the cords. He soon realises that the word underlined with red is "red," and so can proceed.

If there is trouble in writing the answer, the child draws a line with the appropriate crayon, and writes "5 inches" beneath it, but we find that he soon picks out the words "red cord" or "blue cord," and writes these with the correct figure when he has measured it on his ruler.

In this stage the children have been introduced to the conventional ways of measuring, and have performed one operation only, but as they progress, they pass to a sequence of experiences which show the underlying principles of the four arithmetical processes.

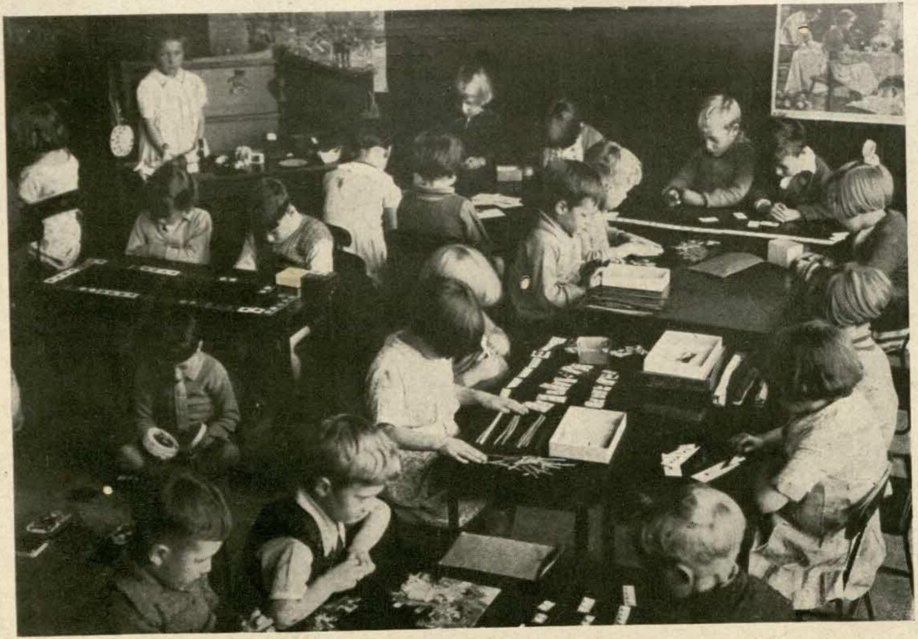


PLATE III

Early sorting exercises. Billy (on the mat), sorts " Big " and " Little " boxes, while dominoes and jig-saws occupy the attention of his friends.

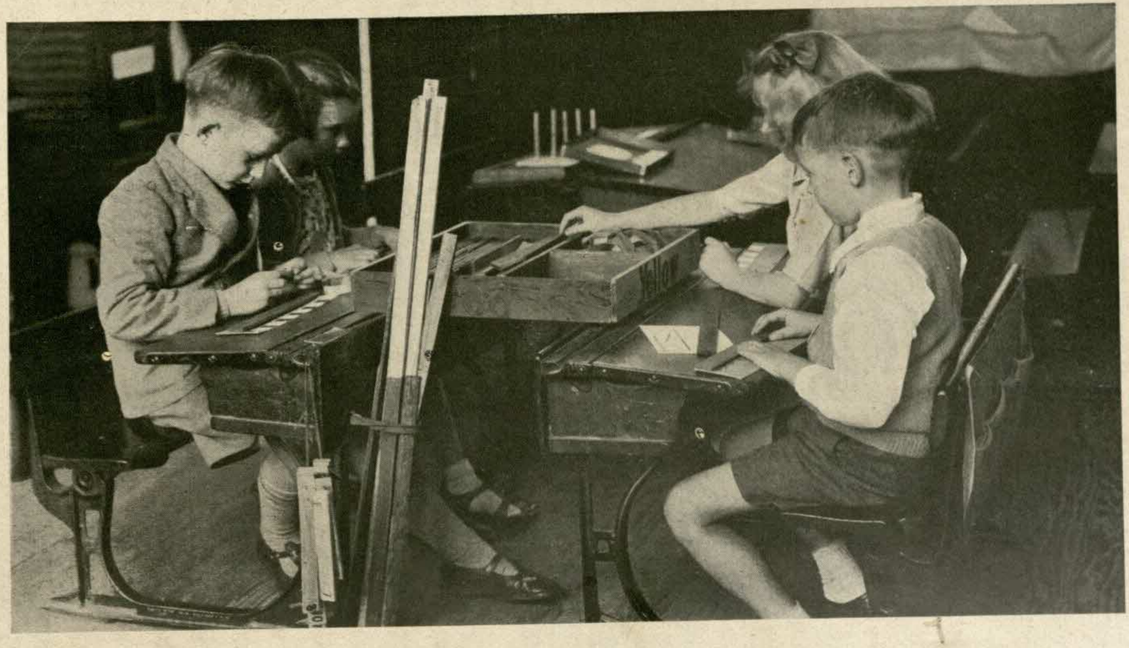


PLATE IV

Measuring equipment. Notice the " measuring box," the yard sticks and loose inch strips, the home-made rulers, and the pictorial question cards. Other exercises are in the hanging pockets.

Length Box

A useful piece of apparatus which the children use as soon as they pass to the second stage of their work is the "length box." This is seen in the illustration (Plate IV), arranged between two desks. It is a shallow wooden box, containing three divisions, one long and two short (Fig. 3). Wood is not essential—we began with the lid of a cardboard box, until someone gave us something more substantial.

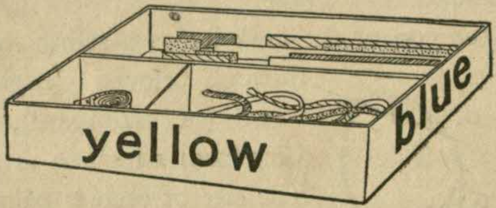


Fig. 3

Inside the long division is the word STICKS—letters cut out of black paper, pasted on to the bottom of the box; in the short divisions are the words TAPE and TAPE-MEASURE. The sides of the box are painted red, blue, yellow, and green, with the colour names in black. Within is a collection of sticks, tapes, and measures.

The sticks vary from 1 inch to 11 inches in length, and are cut from 1-inch lath, stained red, blue, yellow, or green. The tapes, of the same four colours, vary from 2 inches to 24 inches, and as we have a staple-fixer in school, the ends are neatened by being turned down and fastened by a staple. The tape-measure is for use with circular objects.

OTHER MEASURES

Standing between the desks is a bundle of taller sticks. These are laths, 1, 2, and 3 feet in length, also yard, half-, and quarter-yard sticks, which, when not in use, stand in a leather loop nailed to the back of the desk.

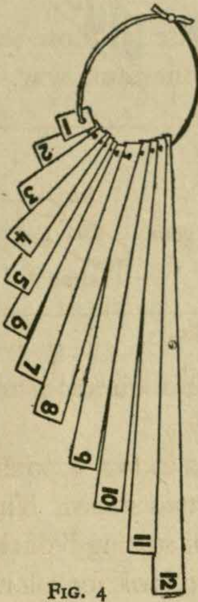


Fig. 4

At the end of the desk hangs a string threaded through eleven lengths of wood (or cardboard), which vary from 1 inch to 11 inches. The size of each is painted on the end, and it adds to convenience in using if the figure is painted on both sides of the length, thus avoiding much turning over of sticks (Fig. 4).

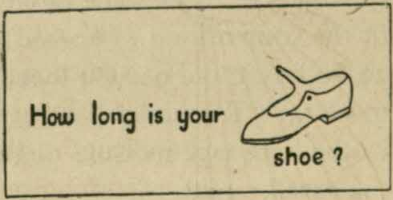
With the length sticks the children measure doors, floors, etc. Sometimes they need odd inches in connection with a larger measure. Donald, seen in the illustration (Frontispiece), measured the door, and found it "just a bit over the yard stick." Taking the string of short lengths, he found one which fitted the space, and decided that the door was "1 yard 2 inches" wide.

The short sticks and tapes in the box are used in connection with the measuring exercises which are kept in wall pockets hanging at the back of the desks.

EXERCISES

At this stage reading is still a difficulty to some children, so the first exercises are given mainly in picture form.

One pocket contains such exercises as those seen in Fig. 5, and all are worded in the same way, so that a child soon recognises the phrase, "How long is . . . ?" and as the name of the article is written beneath the picture, he can understand his question and write the answer without difficulty.



How long is your shoe ?

FIG. 5

The next type of question is seen in Fig. 6, where the oblongs are coloured to show two sticks. This exercise is a sequence to the "stick sorting" of the first stage, for the child now has to look for a long red stick and a short blue one. He takes them from the box, measures them on his ruler, and writes down, "The red stick is 9 inches, the blue stick is 4 inches." If he does not know how to write the word "stick," he finds it inside the box, and the colour words are painted on the corresponding sides.

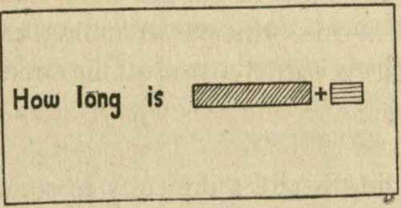


FIG. 6

From the beginning the teacher has, in addition to these practical exercises, balanced her work with very carefully prepared mental lessons, and by now the child has made some progress in his knowledge of the composition of 10 and of number bonds to 20, so he can put 9 and 4 together and believe them to be 13. To check his answer, he takes the sticks to the long tape-measure pinned by the teacher to the wall, puts them on it end to end, and reads off the answer 13. He is beginning the process of addition.

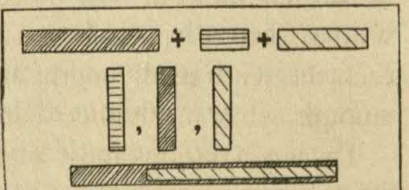


FIG. 7

Being successful with this series, he takes a card like that in Fig. 7, which introduces him to more of the basic operations. For the top exercise he selects three sticks and adds them together. For the second he chooses three of the same length, though differing in colour, and finds he has the same measurement three times—the principle of multiplication ; and for the last he partly covers a long green stick by a shorter blue one, and sees what is left.

RECORDING RESULTS

At this stage there is no attempt to record results in conventional terms. If a child can say that he has "put 7 inches over 10 inches and that left 3 inches," or will say, " I've got 15 inches here—it's this 9 inches and that 6 inches," he is making good progress.

Similar advance is shown by a group of children using " lace "—strips of cap paper cut as for the first-stage work. Peter has given the other three 5 inches, 8 inches, and 6 inches respectively, and while they find out how much they have together, he measures the piece he has left. Then he gives each the same small length, and they find the total amount, while finally they share a length by folding.

Their conclusions must be put down as they are reached, and the papers of the group at the end of the period will read :

" Enid had 6 inches, Bob had 9 inches, Philip had

5 inches. We had 20 inches together. Peter had 5 inches left. We had 4 inches each. It came to 12 inches. We had 13 inches. We fold it into . It was 4 inches and a bit."

THIRD STAGE

In the third stage, different-coloured cards are used for different types of exercises. Measuring cards are green and are numbered according to difficulty. The folder in which they are kept is recognised by the design of rulers and tape-measures, coloured by the children in Art lessons (Fig. 8).

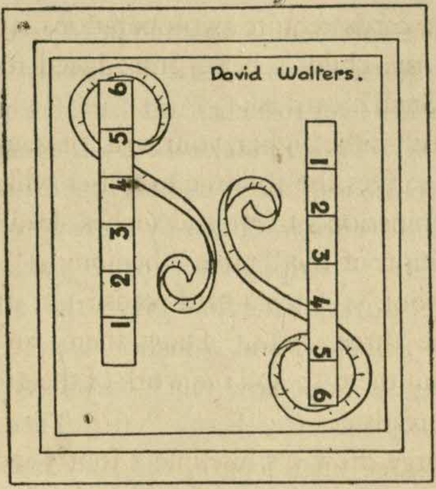


FIG. 8

Now that they can read more difficult words, terms such as "tall," "wide," and "high" are introduced with simple exercises such as they performed previously, the application being extended as their skill increases.

Stage 1 cards read as follows :

1. How long is this card ?
2. How high is my chair ?
3. How tall are you ?
4. How wide is a ruler ?

Stage 2 cards require two operations, and unconsciously the child is being introduced to the four rules. Such a card is :

"Which is the bigger, your wrist or your ankle ?"

Stage 3 gives the children exercises which require the combination of feet and inches, leading to the composition of the "table" beginning "12 inches make 1 foot." Such a card reads :

"Take three sticks. Draw them, and make a sum about them"; and the work of the group when finished reads :

"George drew a white line 1 foot 3 inches long. Ronnie drew a blue line 3 feet 6 inches long. Alec drew a red line 2 feet 4 inches long. Joan measured the whole line. It was 7 feet 1 inch long."

CHAPTER V

SHOPPING

FROM the earliest to the latest stages in this scheme of Practical Number, " Shopping " is one of the most valuable forms of activity.

But it must be regarded as a progressive means to a mathematical end—not primarily as a decorative adjunct to the classroom, not as a plaything.

Because art is educative, it is desirable that the shop shall look as attractive as we can make it, but the essentials are :

1. That the child shall gain from it experience of real shopping.

2. That the stock shall be such as to afford him exercise for the skill and application which should be demanded by his expanding intelligence.

THE FIRST SHOPS

The shops in the earliest stages are designed to provide the children with their first experiences of weight, length, capacity, and money, so we have four of them—SWEETS, RIBBONS, MILK-BAR, and TOYS.

Their construction is very simple. The "Ribbon" shop is only a kindergarten table. As described in the "length" chapter, the measure is pasted on to the table and the stock is lengths of brightly coloured crinkled paper, cut in 1-inch widths, and similar strips of plain paper, painted by the children and wound on to big cotton reels and old film spools. This shop also keeps "lace"—lengths of cap paper cut in narrow widths and vandyked by the children along one edge.

The "Toy" shop is another table with a front and sides, made of plywood, slipped round it. The sides are hinged as shown in the diagram (Fig. 9), so that when not in use the whole can be taken off the table, folded flat, and put away. The plywood

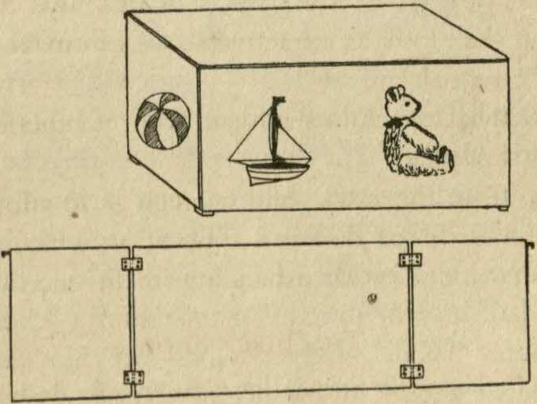


FIG. 9

is given a coat of clear varnish, and a few brightly coloured cut-outs of toys are pasted on it.

The simple toys on the counter have a little label tied to each, showing the price both as a figure and a number picture (Fig. 10). When a child comes to buy, he can, if he has forgotten the figure, count the price from the number picture, and see that the pennies he tenders correspond to the dots on the price.

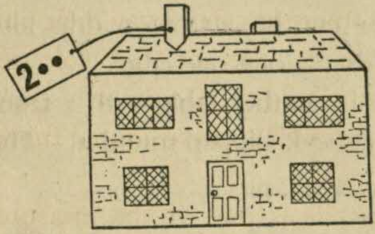


FIG. 10

The "Sweet" stall is another table, and has a pair of toy scales—price $4\frac{1}{2}d.$ from a wholesale toy store—and a few weights—large cowrie shells. The "sweets" are tiny balls of clay, rolled by the children, and painted, when dry, with bright colours. There are also jars of split peas and haricot beans boiled for two minutes in dark-brown dye to give them a chocolate colour. "Kali"—silver sand—provides an excellent exercise in balancing. These sweets are kept in shallow boxes or wide-mouthed jars, and when a customer asks for them they are balanced against the required number of cowries.

The "Milk-bar" is a table covered with

brightly coloured American cloth—for use as well as ornament—and has " lemonade " (water coloured with yellow paint), " raspberryade " (red paint), and " milk " (water to which white paint has been added) for sale. These are, as seen in the illustration in the " Capacity " chapter, kept in large bottles and stand in a big baking tin, enamelled white to prevent rusting. A few empty medicine bottles and jars are provided for the customers to carry away their purchases. The measure is one of the coloured " bandalasta " egg-cups sold at Woolworth's, and the bottles are filled through a tiny coloured funnel sold at the same stores.

A pennyworth of milk is one of the measures full, and the exercise demands considerable skill on the part of a five-year-old, both to ensure that the measure is really filled and that none is spilled in the process.

As 10 is the unit with which the children work at this stage, they begin their shopping with ten pennies, and no change is given. Having counted them out from the teacher's box, they buy from all stalls, and every transaction must be recorded. We recognise drawing as a means of expression, and in these early stages a child soon has on his blackboard or paper a series of little pictures with the prices at the side.

Such a picture is seen in Fig. 11, and is a record of two days' shopping.

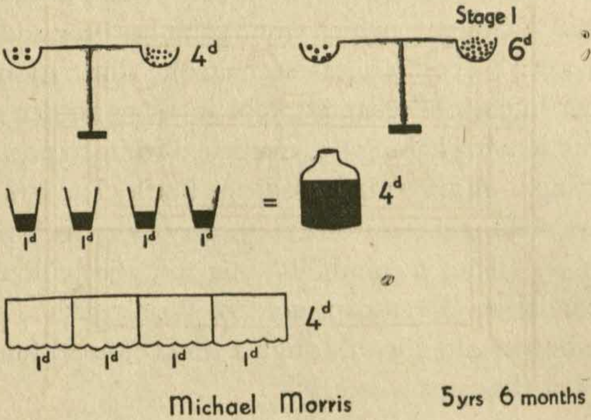


FIG. 11

SECOND-STAGE SHOPS

Our six-year-olds have used two types of shop. The first was a simple structure built on a foundation of a small three-sided clothes-horse, which enclosed the shop on three sides. Hessian stretched over the clothes-horse made its walls and also provided a good background for the display of goods.

The two " wings " of the horse made the sides of the shop, and a strip of wood, the length of the stall, had two short parallel strips nailed across the under side of each end to make a groove, which fitted over the middle bar of the wing sides, and so made a steady counter. This is seen in Fig. 12.

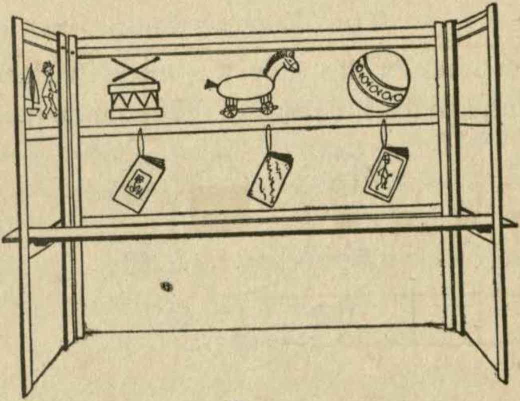


FIG. 12

The second shop was used when space was more limited, and is seen in Fig. 13. It is a desk with laths nailed up the front to make a window, and also to hold the name card. Two shelves nailed to the wall behind held the greater part of the stock. Shops such as these are seen in

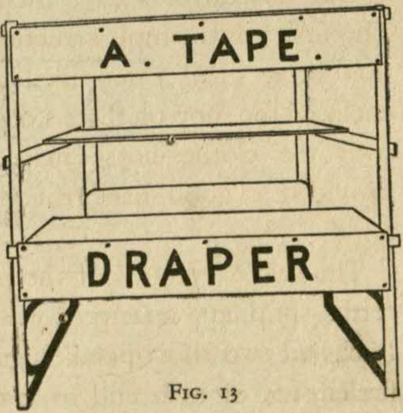


FIG. 13

the illustration (Plate V), where they are the "Draper's" and the "Confectioner's."

THE DRAPER'S SHOP

The stock of this shop was made in Handwork lessons, and teaches many of the common numerical terms. Many articles were required in *pairs*. Socks were cut from blue sugar paper, and gloves, for left and right hands, from wall-paper. Pairs of

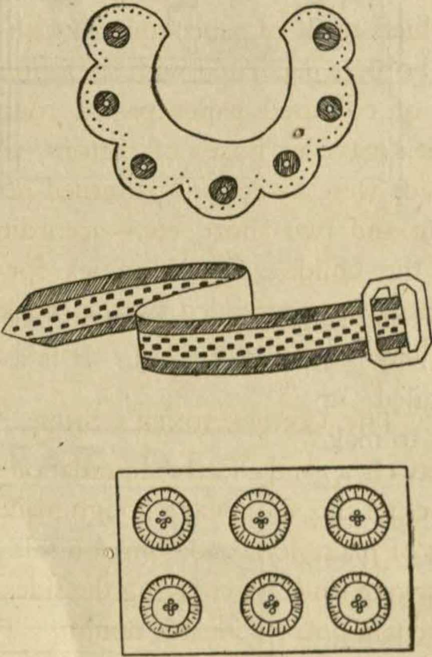


FIG. 14

knitting pins were made with paper rolling, and knobs of twisted tissue paper stuck in the ends.

Buttons, cut out of cardboard, painted, and fastened to cards, were sold in *dozens* and *half-dozens* (Fig. 14).

The collars and belts seen in the same illustration were made of paper and painted, and there were handkerchiefs made of paper squares with scalloped edges or borders decorated with stick printing.

Bands of coloured paper pasted round empty cotton reels gave us boxes of cottons, and paper-rolled beads were made into patterned necklaces—three long and two short, etc.—according to the taste of the child. Opportunities for accurate measurement were provided by the blocks of tape and lengths of ribbon and lace.

The Confectioner's Shop

The very cheap and effective foundation for much of the stock of this shop was a dough made of equal quantities of plain flour and common salt.

Loaves were made by covering the sides and tops of empty chalk boxes with this dough. They were then slowly dried over the radiators or in front of a fire, and when thoroughly dry were painted with varnish paint, stone colour being used for the white loaf and dark brown for the wholemeal. It is important to use this paint, as otherwise the mixture absorbs the damp from the atmosphere and is spoiled.

FIG. 15

Quantities of natural-size buns and cakes were made in the same way by the children, Swiss rolls, éclairs, and jam tarts being particularly successful (Fig. 15).

Excellent biscuits were made from this dough, rolled out and cut with a pastry cutter, and family cakes with almonds on the top and birthday cakes adorned with candles were made on foundations of round biscuit tins.

Chocolates made of the same mixture and painted were arranged in boxes covered with wall-paper, and toffee apples were stuck on butchers' skewers.

All these productions have been in daily use for very many months and are still in excellent condition.

Old *Radio Times* copies were used to make blocks of chocolate. One cut in quarters made four blocks, and these were made correct weight by being wrapped in " lead " paper from tobacco. They were then covered by coloured papers painted in Art lessons, the varieties being copied from the real thing.

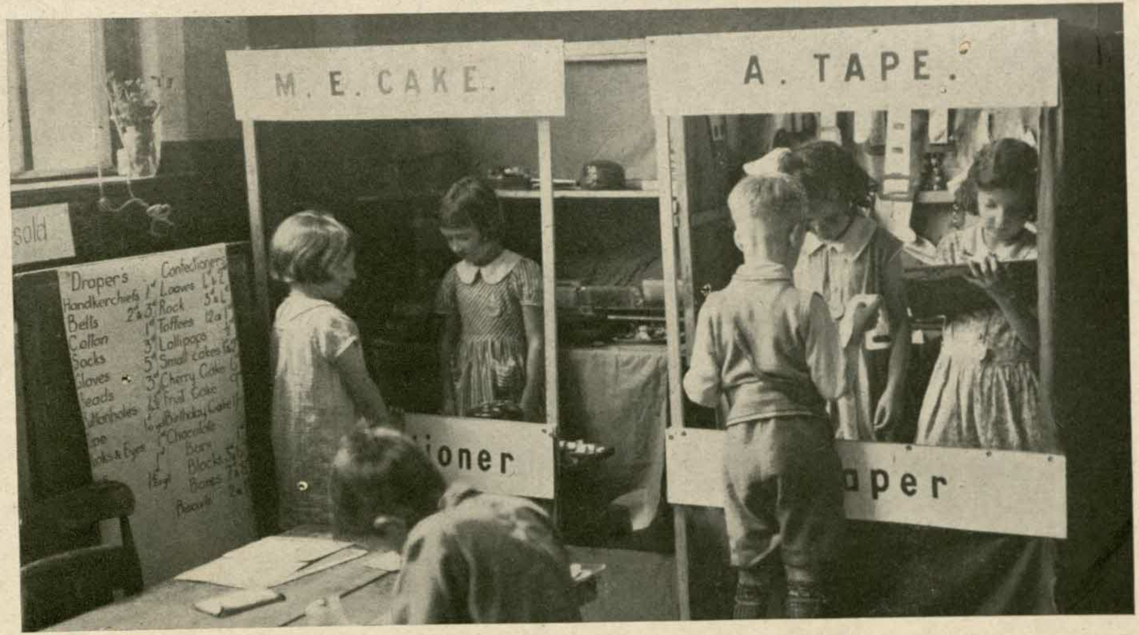


PLATE V

Two class shops. All stock is home-made, whether cakes, sweets, belts, or necklaces. The bills are made up with the aid of the stock list pinned to the wall.

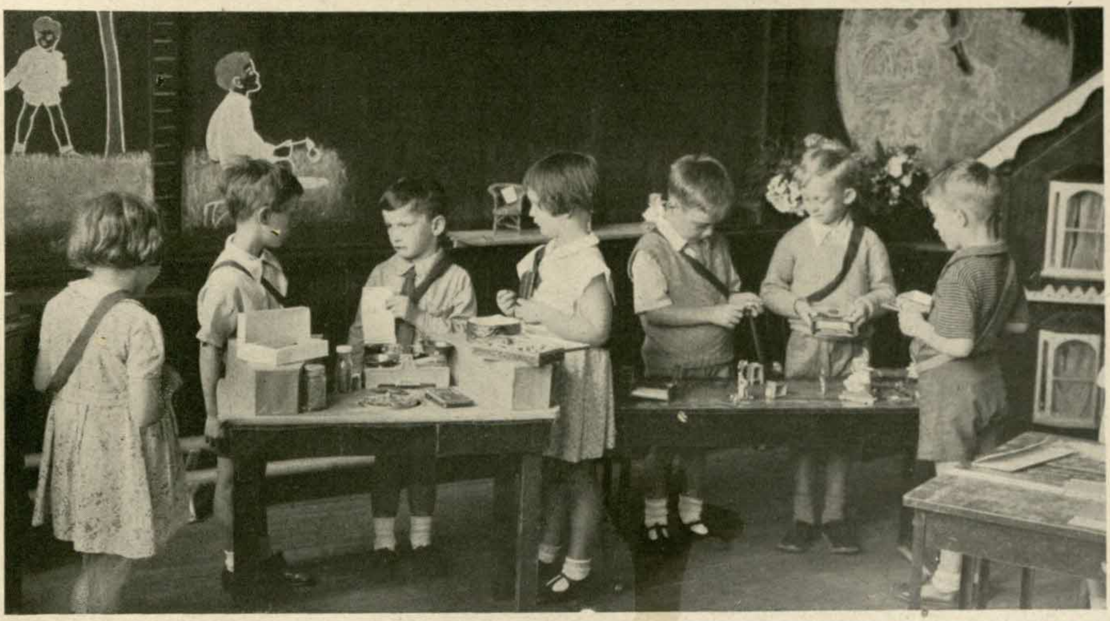


PLATE VI

First activities. The " Sweet " shop where cowries buy goodies, and the " Toy " shop where each article bears its price in a number picture as well as a figure.

Butterscotch was strips of plywood, 1 inch by 3 inches, wrapped up in silver paper, and sticks of rock were made by painting coloured stripes on fat paper rolls.

SHOPPING

The articles in these shops are priced up to 1*s*., and the children set out with a whole shilling and twelve pennies in their purses, the shopkeepers being provided with pennies for change.

Each article has its name printed on the back or base, and a list of the goods and their prices is put up by the side of the shops.

Work for four children is provided by each of the shops shown in the illustration (Plate VI), two buying and two selling. Every transaction must be recorded, under the heading of "I sold" or "I bought," so that at the end of the period each child has a complete "bill."

THIRD-STAGE SHOPS

The shops for the seven-year-old children are like those used in the earlier stages, but their stock is different.

In the first stage, "shopping" helped a child to realise number values, and to grasp the ideas of length, weight, and capacity. In the second stage, he worked with conventional measures and had practice in money-changing, but in the third stage he should combine the experiences he has already gained in separate measuring, weighing, and capacity exercises with the operation of shopping. Thus the shops of the third stage must contain stock which needs to be weighed, measured, and cut before it is sold.

For this reason we are very unwilling to allow any of these shops to be stocked with " dummy " packets, obtained from commercial firms. Though these *look* real, there their value ends, for the only exercise such a packet provides is to require the giving of change, and that has already been afforded by the work of the second stage.

Moreover, the use of such packets excludes any opportunity for the extremely valuable exercise of approximation of weight, as a " ½-lb." packet of tea is no heavier than " 1 oz." of tobacco.

In our opinion, all stock used at these shops should be either the real thing, or packets made up by the children in imitation of the real thing, and containing the real weight in stones, sand, sawdust, or " lead " paper.

Here, too, there should be opportunity for liquid measurement, and if " ½ a pint of vinegar " is wanted, it must be measured from the bottle of brown paint-water on the shelf.

Biscuits made as in the earlier stages, lentils, sugar (coarse sand makes less mess than the real thing), tea, beans, peas, and sago are all useful dry goods, and yellow plasticine, moulded into round cakes, makes excellent "cheese" and "butter." These are cut easily with a length of fine wire, fitted with a stick handle at the end (Fig. 16).

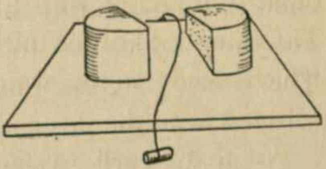


FIG. 16

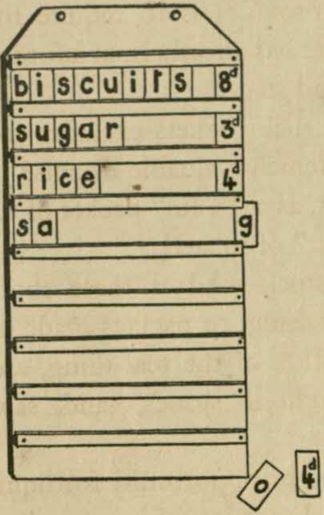


FIG. 17

The price lists are made up each day and the loose letters and figures slipped into the grooves on a board (Fig. 17).

We make these boards by first nailing on ½-inch laths, 2½ inches apart, and then superimposing 1-inch laths. Cards 2½ inches high are slipped into the spaces, and the ¼-inch protrusion of the wider laths prevents them from falling out.

The children in this stage usually start shopping with a half-crown, and the shopkeepers are provided with coppers and small silver for change. Each child *must* buy, during the shopping period, at least one thing which has to be weighed or measured. The other purchases may, if he so wishes, be selected from the tins and packets on the stall.

As in the earlier stages, each transaction is recorded under the heading of "I bought" or "I sold," and at the end of the period the amount of change left, or the money taken, completes the statement of accounts.

CHAPTER VI

WEIGHING

THE first stage in weighing is entirely a matter of balance. For that reason, it is centred round the "Sweet" shop, as described in the chapter on "Shopping," and we are very careful to see that this stock consists of *tiny* sweets, sand, and lentils.

The reason for this is that it is important that a child shall be able to observe the exact point at which the scale pan "goes down," and if he is using large sweets or big beans, the gradual approach of this point cannot be noticed.

As in every other activity, having had the experience of weighing, the child clarifies his knowledge by making a drawing on his blackboard or paper of the scales, the number of cowries used and a representation of the quantity of sweets obtained. One of these is seen in Fig. 11.

THE SECOND STAGE

When the children pass to the second stage, they begin to use the conventional units employed and the phrases associated with this activity. At this stage, too, they begin to compare and contrast quantities—the introduction to the four basic operations.

As seen in the illustration (Plate VII), the children sit at two shelves fixed against the classroom wall, the narrow, upper one holding tins and jars of peas, haricot beans, shells, beads, lentils, rice, large sago, and butter beans dyed red, blue, yellow, and green. We did this by boiling them in dye for two minutes. When dried, we found that some of them seemed spoiled by a white deposit on the skin, but this rubbed off very quickly when the beans were used, and the desired colour shows admirably.

On the lower shelf (or kindergarten table) are the scales and balances, some weights, and in the wall pockets behind the jars a few graded problem cards.

The two pairs of scales at the first table were given by kindly shopkeepers who had discarded them in favour of automatic scales—and the balances were made as shown in Fig. 18, with a school ruler, at either end of which hung an inverted lid of a polish tin, suspended by three light chains. We found, by experiment, the spot at which the lids balanced, and drilled a hole there. The ruler is suspended by a bolt and nut between two laths screwed to a wooden brick from the toy box.

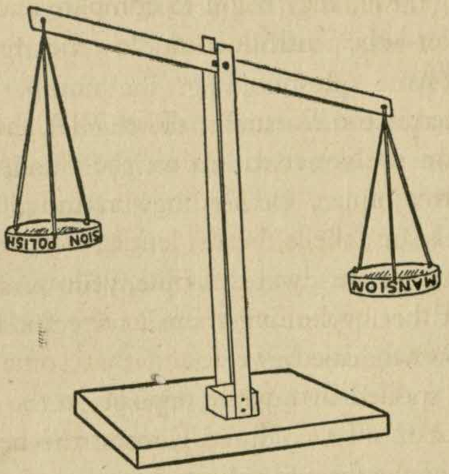


FIG. 18

STEPS IN WEIGHING

The first exercises given to these children, after they had had a period of free experiment, were in picture form, and introduced the word "balance"

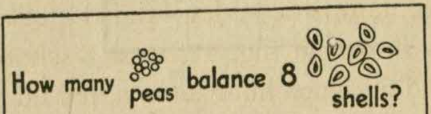

How many peas balance 8 shells?

FIG. 19

as well as the now-familiar phrase "How many . . . ?" (Fig. 19). Such a card requires a written answer, such as "18 peas balance 8 shells."

When the children found that, owing to variations in size, it was possible to find two right answers to the same question, e.g. the number of peas which balance three shells, the teacher gave a class lesson on the conventional weights, and, in particular, the ounce, before they returned to their activities.

Ounce weights were not plentiful, and, even if they had been, were very small for little fingers to hold; so we made our own.

This was done quickly, cheaply, and easily by folding a foot of coloured nainsook (bought from the sixpenny stores for 2*d.*) and marking it as shown in Fig. 20. It was machined on the *black* lines and cut on the *dotted* ones, and gave us sixteen little bags. Fine sago was put into these, and when *bag and contents* weighed 1 oz., it was sewn up securely and "1 ounce" written on it in Indian ink.

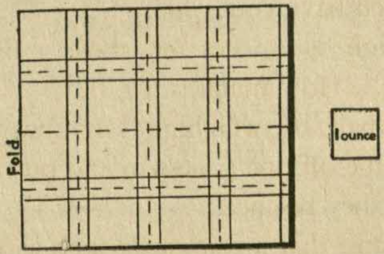


FIG. 20

SECOND-STAGE EXERCISES

As soon as the children had had some practice in using definite weights, they passed to questions which demanded their use. These questions introduced the four basic operations, though at this stage there is no attempt made to write down the result in conventional form. These were some of the exercises :

1. Weigh 4 ounces of rice, 3 ounces, and 2 ounces. How much have you altogether ?

2. Weigh 8 ounces of peas. Use 5 ounces. How much is left ?

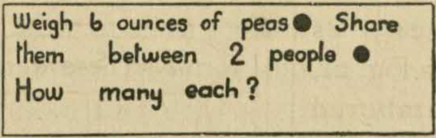
3. Serve 5 ounces of lentils to each of 5 people. How much have you sold ?

4. Weigh 4 ounces of shells. Find half by weighing. How much is it ?

The " half by weighing " is always found by taking some off one scale pan and putting it on the other till they balance.

We found that a few cards such as these, which suggested exercises to the children, were of great value, but that once they realised the uses to which they could put their material, they could compose their own exercises, and the function of the teacher was no longer to invent sums, but to show the children how to state the results they had obtained.

We noticed that children at this stage found great difficulty in separating the steps of an exercise, so we adopted the device which in Fig. 21 appears as a large full stop. It is painted bright red, and the children call it a " Belisha." Each of these spots indicates the end of one operation, which must be performed and the result stated (or written) before the next is attempted. Then, when the final conclusion is reached, the child has before him a series of steps through which he has reached an intelligible result.



Weigh 6 ounces of peas ● Share them between 2 people ● How many each?

FIG. 21

THE THIRD STAGE

As has been sketched already in the " shopping " chapter, part of the third stage of work in weight is centred round the " Grocer's " shop. This gives the children actual practice in fractions of a pound, but they also need opportunities to perform, with weights, various exercises which will provide further work in the four basic operations.

So, in addition to the shop, they continue to work at the weighing shelf, as in the second stage. These exercises are graded so as to employ the children to their *fullest* capacity, and ensure that their previous experiences shall be clarified and their newly acquired skill applied.

The weight cards are blue, and are kept in folders decorated by the children, as shown in Fig. 22, and numbered according to difficulty.

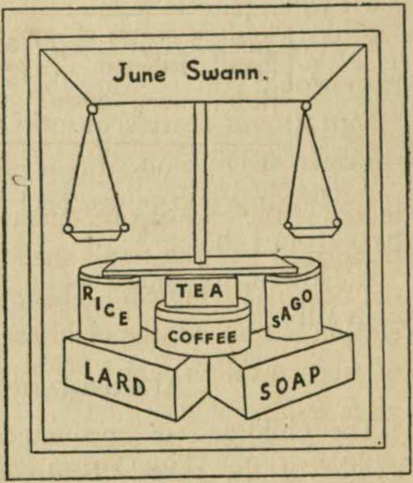


FIG. 22

Stage 1 *cards* require several different weights to be put together—the process of Addition.

1. Weigh a long parcel, then a square one. How much do they weigh together?

2. How many books does it take to balance 1 lb.? What does each one weigh?

Stage 2 *cards* compare or contrast the weights of two objects—the process of Subtraction.

1. Weigh a large parcel, then a small one. Which is the heavier? By how much?

2. May bought ½ lb. of tea, and Hilda bought

6 ounces. Which bought the most? How much more had she?

Stage 3 *cards* take the same quantity a number of times—the process of Multiplication.

1. Find a parcel to balance the 2-ounce weight. What will 4 parcels weigh?

2. How many cream biscuits weigh 1 lb.? How many would you get for 4 lbs.?

Stage 4 *cards* share a quantity—the practical performance of Division.

1. How many 2-ounce packets of rice can you make from 1 lb.?

2. How many children can have 3 biscuits each from ½ lb.?

APPROXIMATION

The children are encouraged to estimate the weight of the parcels before checking their answers, and "guessing" weights is a very popular exercise at this stage. A page of a home-made exercise book in which such an exercise is recorded reads as follows:

"This morning we guessed the weight of a duster. Pat guessed 1 ounce, Peter guessed 4 ounces, Doreen guessed 2 ounces. It weighed 2½ ounces, so Doreen was nearly right."

CHAPTER VII

CAPACITY

THE needs of the first stage of the measurement of capacity are met in so satisfactory a manner by the experiences of the "Milk-bar," which has been described in Chapter V, that for the five-year-olds we provide no further exercises in this activity.

When these little folk have spent their pennies, they make drawings of their purchases in the same way as they do in other activities, and one of these is seen in the second line of Fig. 11.

THE SECOND STAGE

The children who are working out the exercises set for the second stage of the work are concerned mainly with the ordinary utensils used for capacity in everyday life, and through the use of these are practising comparisons and contrasts.

As the illustration (Plate IX) shows, they work in groups of four, at two kindergarten tables put together and covered with American cloth. On each table is a green-enamelled bath filled with water, and on a cup hook screwed into each corner hangs an old duster.

The utensils include spoons, cups, jugs, a kettle, a tea-pot, milk and medicine bottles, cartons and tumblers, as well as the conventional ½-pint, pint, and quart measures. They are kept on the floor under the table, or, when space permits, on a shelf on a nearby wall.

The questions, in the customary picture form, stand on the tables in hinged pockets. These are made of stiff cards hinged together with a strip of tape. In front of each card is a piece of celluloid, the three sides being framed with passe-partout. The question cards, which are kept when not in use in a wall pocket, are slipped beneath the celluloid when the child is at work, and so are protected from any splashes. As the frame stands in the middle of the table, it can be used by two children, one standing on each side of it (Fig. 23).

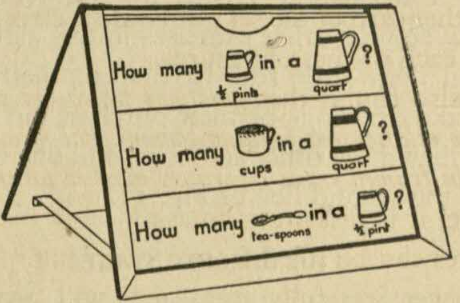


FIG. 23.

CONSTRUCTION OF EXERCISES

When constructing the exercises, we found it necessary to frame each set round one particular set of utensils, as otherwise there are delays among the groups of children. The only measures which appear frequently on the cards are those of which it is easy to obtain a plentiful supply, such as cups and spoons. Thus, in Fig. 23, the child needs the ½-pint and the quart measures, so these will appear in no other card of the set until our stock is increased to two each of these measures.

We also found that *questions which are designed to teach the relationship between conventional measures must always be framed round accurately marked utensils.* For instance, it is disastrous to ask " How many ½-pint measures can be filled from a quart jug ? " because the answer, carefully measured, will probably be " 4½ " ; as a household jug is almost always generous measure.

Therefore, if standard measures are to be compared, we use actual measures or utensils, such as milk bottles, on which we can rely ; while if the aim of the question is only to test careful working and comparison, then unconventional measures can well be used, an example of such a question being : " How many doses of one teaspoonful can be taken from bottle A ? "

METHOD OF WORK

From the very beginning there is a definite order of procedure when measuring capacity, as otherwise it is possible that the children might get very wet and cold.

The child reads his question and selects from the shelf the two measures he is to use. He stands the larger in the bath (steadying it with one hand if it requires it) and fills it with the other vessel, counting carefully in the meantime. Should there be any splashes or overflow, they fall into the bath, without any damage being done. When he has found the answer to his problem, he leaves *both* utensils in the water while he writes down his conclusion, after which he takes out and empties each measure in turn (as the water is not deep, this only involves wet finger-tips), dries it, and returns it to the shelf.

In this way neither the child nor the table suffers, and the performance of the exercise offers additional training in neat habits.

THE THIRD STAGE

In the third stage the children are engaged in more definite work with conventional measures. They use pint, quart, and gallon measures, as well as pint, $\frac{1}{2}$-pint, and $\frac{1}{3}$-pint bottles, together with the cups and jugs of the previous stage.

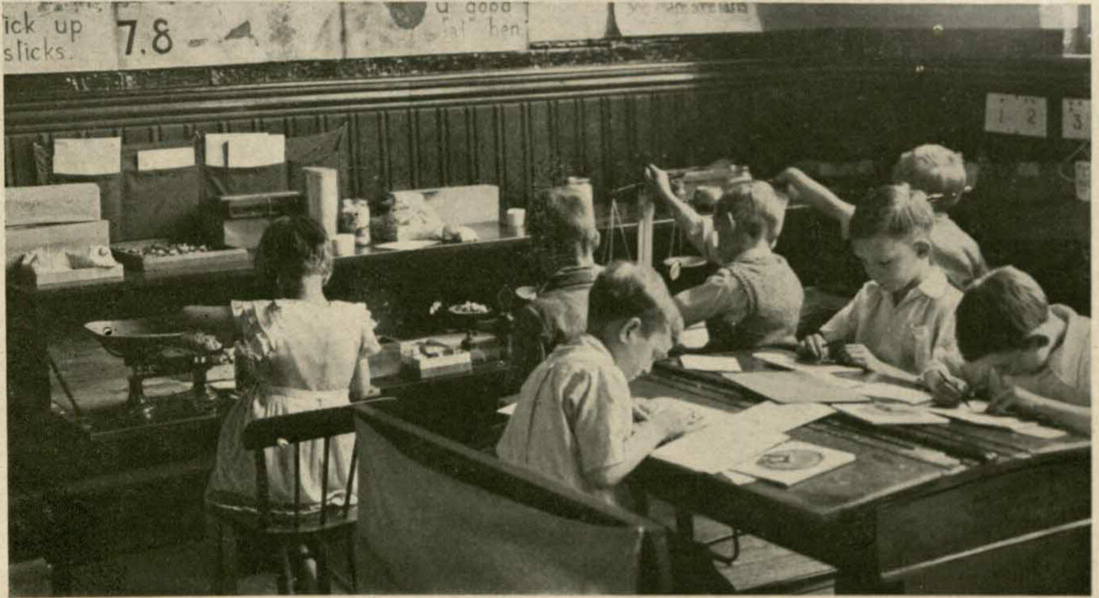


PLATE VII

More advanced weighing, and, in the foreground, clocks. Bruce is using the home-made scales to weigh the parcels and loose goods kept on the shelf.

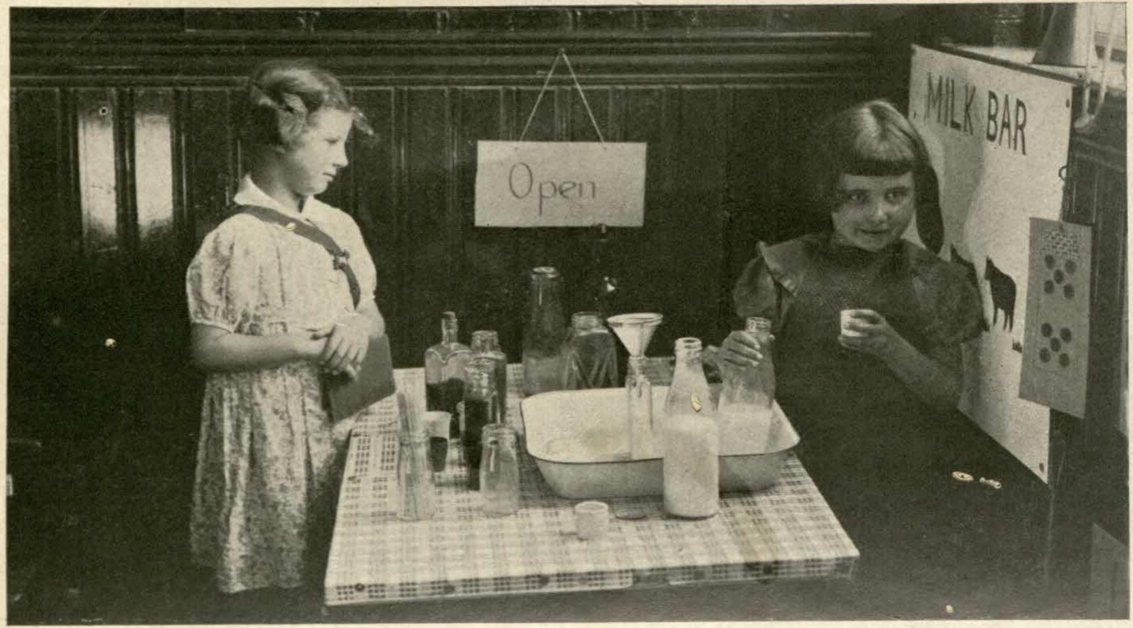


PLATE VIII

The Milk-bar. A measure-full for a penny, and you may have a choice of milk, lemonade, or raspberryade.

The question cards of light-grey cardboard are kept in a folder decorated as in Fig. 24. Representative cards of this stage are:

1. How many pints can a milkman serve from 2 gallons?

2. A man uses ½ pint of milk each day. How much does he use in a week? What will his milk bill be for a fortnight at 3*d.* a pint?

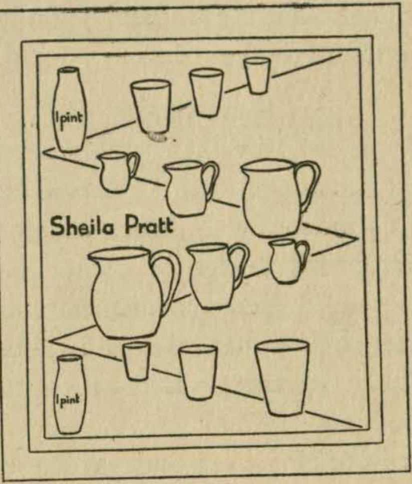


FIG. 24

3. Mother took 3 pints of milk. If 6 children had a cupful each, how much was left?

4. Fill the pint measure and empty it into the gallon can until this is full. How many times have you done it?

CHAPTER VIII

CLOCKS AND CALENDARS

" TELLING the time " is an activity in which the children delight, and we let them begin it as soon as they leave the Reception Class.

FIRST STAGE

The clocks used by these children tell only the hours, and are easily made. On a base of thin wood (or card) 6½ inches by 5½ inches we glue two concentric cardboard circles of contrasting colours, 4½ inches and 3½ inches in diameter, respectively. The smaller circle is marked in hours, but the larger one has only one mark—at the top—to show the completed hour.

With a fret-saw we cut out two wooden fingers, with a marked difference between the long and the short, and, having drilled a hole through the fingers, cards, and wood, we fastened the whole together with a copper " split rivet." If cardboard fingers are used, a paper fastener will do, and if a small piece of leather is glued to the underside of the centre of the base card, it will prevent the fastener tearing the cardboard.

With these clocks, each child has a small circle of cardboard, round which he can draw when he wants to illustrate his work.

The children begin by telling the hour—finding the time at which they come to school, go home, go to bed, etc., and having moved the fingers to the time they need, they draw a circle round the card on their paper and mark in the position of the fingers.

THE SECOND STAGE

The clock to which the children advance in the second stage is seen in Fig. 25. It is made in the same way as the first one, but has four marks on the large circle—the hour, ¼ past, ½ past, and a ¼ to—with the words TO and PAST on the appropriate side of the dial.

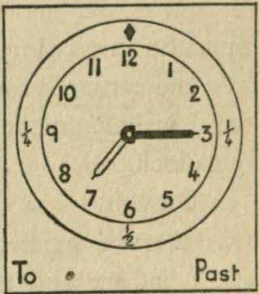


FIG. 25

As soon as the children can find and read times on these clocks and draw them correctly, they pass to the clock shown in Fig. 26. This is marked off on the larger circle in 5-minute intervals, till it reaches ½ past, i.e. 30 minutes past, when it begins to return by 5 minutes to the next hour.

Incidentally, this gives excellent practice in the 5 times table, both forwards and backwards.

When the children are familiar with these two stages, they like to tell the time with both clocks, by putting the fingers in identical positions and writing the time indicated in different ways, such as "7–15 is ¼ past 7," and "½ past 6 is 6–30."

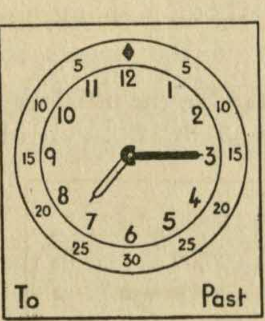


FIG. 26

The exercises in this section are framed so as to give practice in the recognition of a quarter and half hour, and in reading time in two different ways, as indicated earlier. Such a card is :

1. I went home at ¼ past 4. Show this time on your clock.

2. Draw it.

3. Can you write this time in a different way?

4. I had tea at ¼ to 5. Show this time.

5. Draw it.

6. Is there another name for this time ?

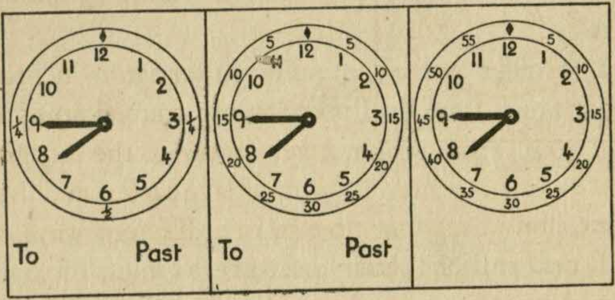
7. How long did I wait for tea ?

The children in the foreground of the "weighing" illustration (Plate VII) are engaged in such exercises as these.

THE THIRD STAGE

Before the children of the third stage pass to the use of the ordinary clock face, they have some practice with clocks made as for the early stages, but marked with Roman figures.

After this they add a dial marked in the usual way



¼ to 8 15 mins to 8 7·45

FIG. 27

to those in use. Now that they are working with minutes up to 60, they have completed their 5 times table, and can read given times in two or three different ways, with the three clocks mounted on one board, as in Fig. 27.

The next step is to use their clocks to help them to solve simple problems, involving the four rules. Some of these cards are:

Card 1

"I played for 15 minutes on Monday, $\frac{1}{2}$ an hour on Tuesday, and 25 minutes on Wednesday. For how long did I play altogether?"

Card 2

"Jack's train goes at 7–35. He got to the station at $\frac{1}{4}$ to 7. How long did he have to wait?"

Card 3

"It takes me 15 minutes to come to school. How much time do I spend every week coming to and going from school?"

Card 4

"Bob and Nell and Joan have to mind the baby for an hour between them. For how long did each of them have to mind her?"

CALENDARS

During this stage of Number work, an old calendar sheet is extremely fascinating to the children, and from it they make a very large number of exercises for themselves. These sheets offer opportunities for the introduction of multiplication tables, for additions and subtractions, and for little problems concerning daily happenings.

Here are extracts taken from a work page based on an " October " sheet :

" October has 31 days. There are 5 Saturdays, 5 Sundays, and 5 Mondays. There are 4 Tuesdays, 4 Wednesdays, 4 Thursdays, and 4 Fridays. There are 4 whole weeks and 3 days over. That is 4 × 7 days, and 3 days as well. That makes 31 days.

" We came to school on 5 Mondays, 4 Tuesdays, 4 Wednesdays, 4 Thursdays, and 4 Fridays. That made 4 × 4 days and 5 days. That is 21 days.

" We were at home for 31 − 21 days. That was 10 days. I had 21 bottles of milk. A bottle cost ½*d.*, so it was 10½*d.* for all the milk I had."

As in the other activities, there is as yet no necessity for the child to reduce each calculation to the conventional " sum " form. What is required is a process, and a statement which proves that he understands its significance. The conventional form, which is, after all, only a short and concise expression of a result, will follow in due time.

CHAPTER IX

MONEY EXERCISES

SINCE the aim of this scheme is to make number a real and vital part of the children's life, it is obvious that the common transactions of the everyday world must play an important part in it.

Accordingly, shops and shopping are very important, and it is essential that, as soon as the children pass to the second stage of their work, they shall have experience of money-changing and combinations of coins.

In the second and third stages a number of cards and exercises are introduced to meet these needs.

MONEY-CHANGING

The earliest of these exercises is the money-changing card (Fig. 28). This is a card, 10½ inches by 6 inches. On the left-hand side is ruled a 2-inch column, and the length of the card is divided into spaces 1½ inches wide. As seen in the illustration (Plate X), in the narrow spaces are written sums of money while in the longer vacant spaces the children place coins which make up the required amount.

At first they choose pennies for this purpose, but before long a shortage in the supply makes it necessary for them to change some of these into silver, effecting also an economy in space.

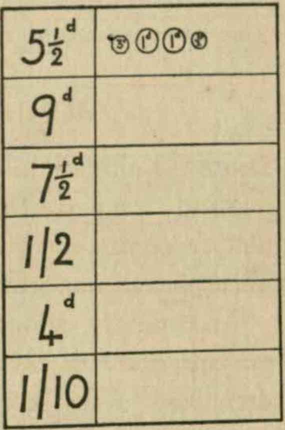


FIG. 28

Once the child has glimpsed the possibility of such conversion, he is encouraged to use the smallest number of coins he can in each case.

He makes a record of his actions by drawing round each coin used, writing the value within it, and finally stating the total of the sum.

A reverse card has the coins attached, and the exercise requires the child to write down what is the sum they represent, e.g. a shilling, a threepenny piece, and a penny is 1*s.* 4*d.*

The cards are graded in three stages :

Step 1 includes amounts to 1*s.*, excluding halfpennies.

Step 2 uses amounts to 2*s.*, still excluding halfpennies.

Step 3 gives practice in amounts to 2*s.* 6d., including halfpennies, for we find that, although the coin itself, as a "little penny," is quite familiar, even to the five-year-olds, three-halfpence, twopence ha'penny, etc., are amounts not understood until the child is 7.

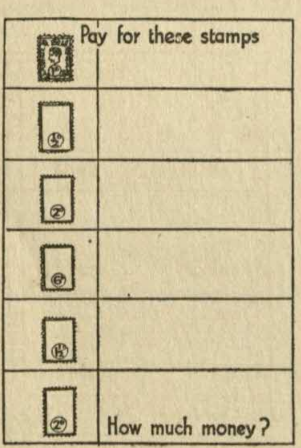


FIG. 29

Stamp Cards

A variation of these money cards is the stamp card shown in Fig. 29. On these are used stamps of different denominations, which have to be paid for by the children. At the conclusion of the exercise the total of the face value is found and checked by the amount of money in hand.

Such cards are easily made, cost nothing, and are extremely useful to the children.

Buses

Bus tickets, familiar to almost every child, provide very popular exercises.

The first one consists of a large double sheet of paper. On the left-hand side are pasted two rows of tickets, of different values, with corresponding spaces beneath. On the right-hand side are two envelopes, one holding tickets and the other a set of exercises.

First, the child matches the tickets, and then, from his coin box, puts coins to their value. An exercise taken from those in the pocket is : " How much would it cost to buy the tickets on the top row ? "

There are two grades in these cards. The first has tickets which do not involve halfpennies, but these are included in the second series.

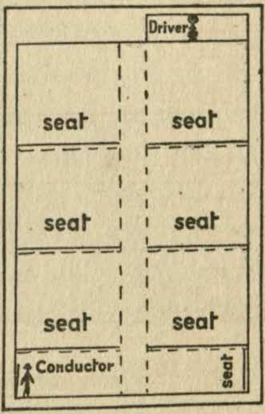


FIG. 30

Another piece of apparatus which is worked with bus tickets is seen in Fig. 30. With this card, about 12 inches by 9 inches, a child has some tickets and a box of coins.

He begins by putting tickets, as he will, on the seats, and paying for them. Then he " writes up " his list of tickets, adds up the face values to find the money he should have taken, and then checks it with the actual coins he has in hand.

In the beginning, we remind the children that it is not necessary to fill every seat each time, as buses are only full during rush hours, but we find that as the children recognise their growing capacity, so they increase the numbers of tickets they use.

When a child is expert at constructing such individual exercises, he uses others compiled by his teacher and graded in difficulty. An early one reads : "A conductor sold *2d.* tickets to every double seat, and *1d.* ones to every single seat on his bus. Put out the tickets. How much did he collect ? "

A later one is : "A father and mother took their two children on a bus. The fare for an adult is *3d.* and for a child *1d.* Put out their tickets. How much money did it cost for them all ? "

SHOPPING SLIPS

This very simple piece of apparatus, seen in Fig. 31, is merely a strip of cardboard on which are illustrations made with rubber stamps, or cut-outs taken from catalogues.

With such a strip and a box of coins a child can construct an indefinite number of exercises. He may begin by buying any two of the articles, then any three, and finally all of them.

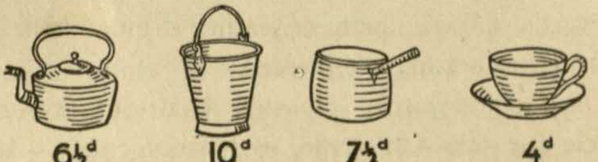


FIG. 31

Then he may choose two or more of any one, or two of one and one of another. Next he may buy each in turn from 1*s*. or from a half-crown; or he may desire to buy any one of them and have only 3*d*. in his purse. How much more does he need?

These are but a few of the uses to which the children put such strips, introducing a variety of operations.

SHOPPING WHEEL

Another form of exercise which involves spending money is the shopping wheel used by the children in the third stage. This is seen in Fig. 32.

It is made of two circles, one larger than the other (for convenience in turning). They are connected in the centres by a paper fastener, and to prevent this wearing through the cards, a little square of leather is glued beneath each centre before it is pierced.

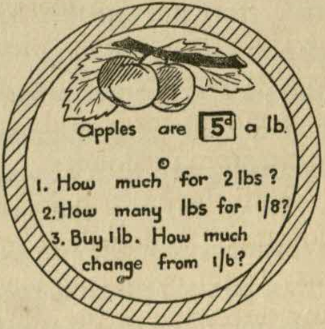

apples are 5d a lb.
1. How much for 2 lbs ?
2. How many lbs for 1/8?
3. Buy 1 lb. How much change from 1/6?

FIG. 32

On the top circle is pasted a cut-out of some article for sale—an apple, loaf, orange, etc.—and beneath it is a caption, saying its price is . . . At this point a small square is cut from the top circle, and the price selected is written within it, on the under circle. The card is then completed by the addition of various questions based on the price given.

The under circle is then rotated a short way, and another price is written in the now empty space. This is repeated several times, so that a child has a large variety of questions presented to him on one card, all of which may be worked with actual coins.

For example, in the exercise illustrated, the child may put out 5*d.* twice, and find the amount. He may then put out 1*s.* 8*d.* and divide it into fivepences—finally giving himself 1*s.* 6*d.*, taking away the 5*d.* spent, and finding his change.

Later he is encouraged to work the exercise mentally, and then check the result by using coins.

When making the questions, it is necessary to remember that the price selected on the lower card must be such that it is possible to give answers to *all* the questions on the upper card, no matter what price is showing. For instance, if on the illustrated card apples were 7*d.* a pound, a child would only be confused if asked to buy a number of pounds for 1*s.* 8*d.* Therefore, on such a card, the price given must be some factor of 1*s.* 8*d.*

CHAPTER X

GAMES—AS NOTATION AIDS

In Chapter II we indicated that it is necessary for children to learn certain facts of notation by heart.

As a help in achieving this result, we find games—both individual and group—of great assistance, as they develop the mental power and alertness required.

There is also a second purpose in providing such educative games for a class, for they not only offer material which occupies a child, but they engage his fullest capacity to a definite end throughout the Number period, so that the teacher of a large class may feel assured that the group working in this way is deriving real benefit.

The beginnings of dominoes and jig-saws have been mentioned in Chapter III. These games are, in the earliest stages, individual, and the children match their colours, pictures, and figures alone. A little later they begin to learn the lesson of " turns," after which they advance to more formal work, at which stage we introduce more group games.

Many of these are adapted from the " parlour " games of an earlier day. Here are a few of such games which we have found to be of use.

SCORING GAMES

1. *Skittles*

This is played in the old-fashioned way, by two children. They have five skittles, a rubber ball, a paper, and a coloured pencil each. Each child has a turn, and writes down the number of fallen men. Later they use ten skittles, have one paper, and record their single scores, and then the combined one.

2. *The Castle Gates*

This is a variation of the skittle game, and is played with a castle outline cut out of plywood, as in Fig. 33. Six gateways are cut out along the bottom, each being large enough to allow a small rubber ball to roll through easily. Above the gates are small cup hooks, screwed into the wood, on which hang cardboard circles, each bearing a number. By varying these, the teacher can make the exercises as difficult or easy as she thinks necessary.

At each end of the castle is a support, which is a 3-inch length of wood about an inch thick. In this is a groove, and when the castle is in use on the floor or table, it slips into these grooves and is quite

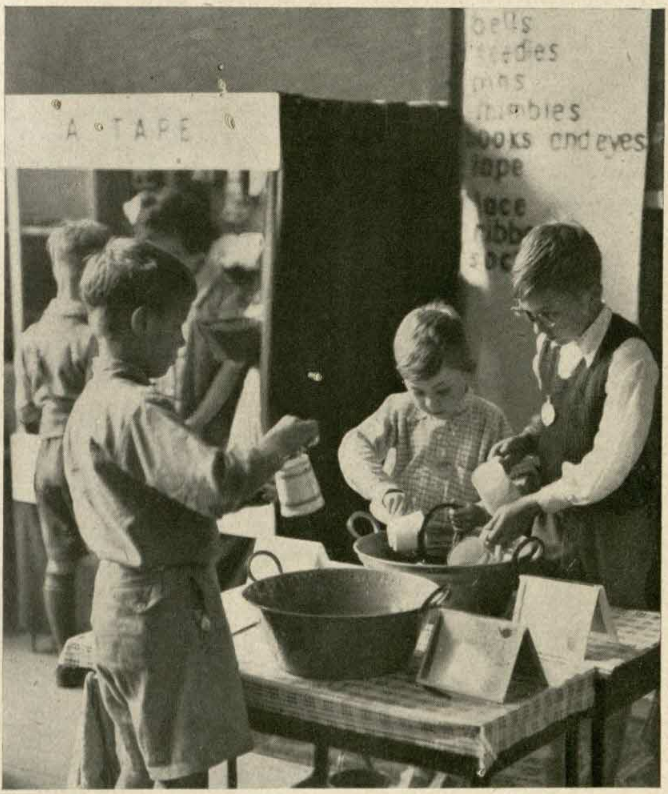


PLATE IX

" Splash ! Splash ! " But all utensils are over or in the bowls, so there is no mess. Note the pictorial questions standing on the table.

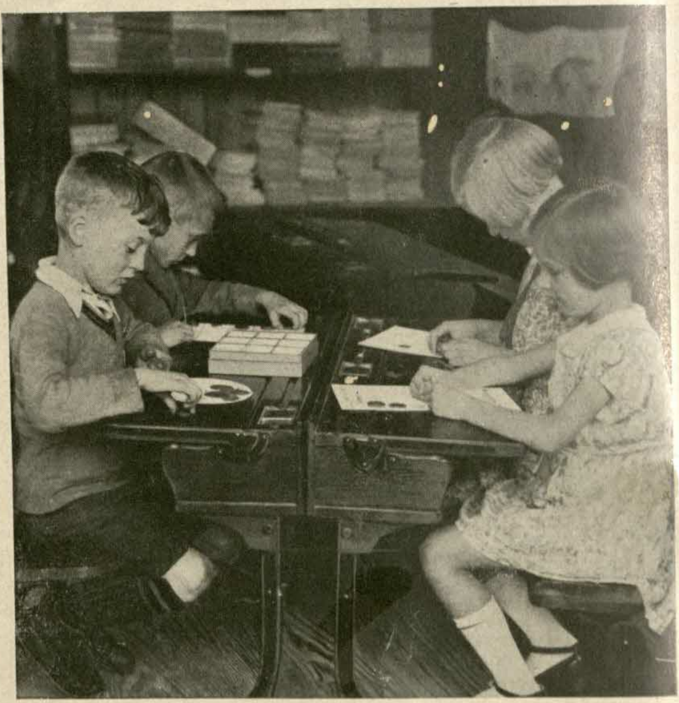


PLATE X

A matter of finance. The boys are using money circles and stamp cards, while the girls are expressing written amounts in real money.

steady. When not required, it is taken out and the whole thing packed away on a shelf.

In the earliest stages the children score by giving themselves as many counters as are indicated by the number above the gate through which the ball rolls. Later they add up the total of two or three individual turns.

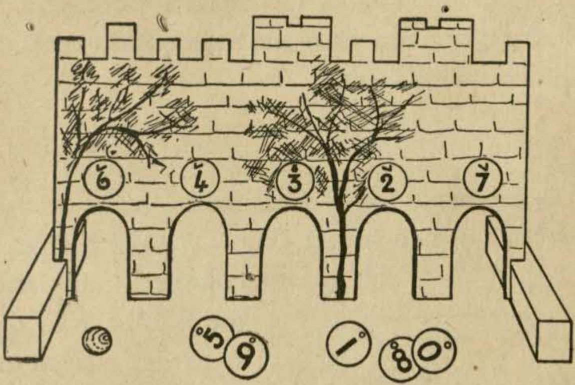


FIG. 33

3. *Quoits*

A simple form is a home-made board made of a square of plywood, into which are screwed five right-angled hooks, with the figures 1 to 5 marked beneath them. The game is played with rubber rings, and can employ four children taking turns and each keeping account of his own score.

At a later stage a more advanced board with hooks and numbers up to 20 employs five children, the fifth acting as scorer. Here "0" is introduced, and the child who has no addition to his score because of it soon comprehends its purport. The final scores are added by the scorer and checked by the individual players.

4. *Tops*

A home-made top is a hexagon of card or wood, cut from a 5-inch square (Fig. 34). On this are six coloured triangles and the figures 1 to 6 (or a harder selection if desired). Through the centre is a butcher's skewer. We find that the top spins better on the blunt end of the skewer.

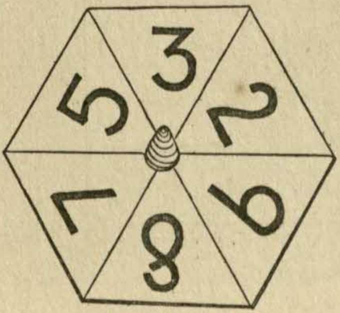


FIG. 34

Two players spin the top in turn, and as it falls each takes from a box of counters the number scored. When both have had a turn, they write down the numbers shown, add up the counters, and so make their first addition sums. These are self-corrective, and in working them each checks the other.

CUBE GAMES

1. *The Dogs and the Bone* (Fig. 35)

This is a home-made game. The "dogs" are cut out of thin wood with a fret-saw and glued to flat wooden stands. The "road" is made of 1-inch squares of paper, two colours being used alternately, and the "bone" at the end is painted on the board. A large wooden cube (from the Babies' brick box) has number pictures, or figures, painted on five of its sides, one being left plain. The two players take it in turns to throw the cube, and move their dog towards the bone, according to the picture which is shown.

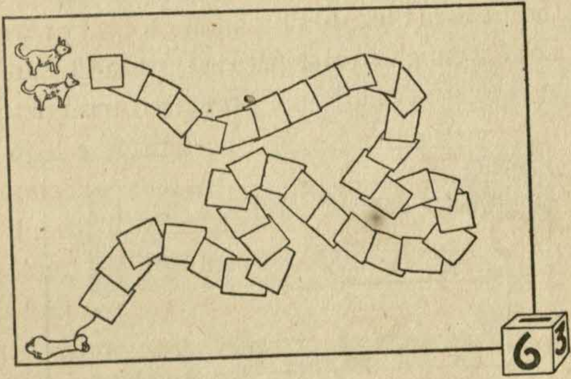


FIG. 35

2. *Snakes and Ladders* (Notation to 49)

The bought variety of this game is, as a rule, too difficult for general use in school, so a simpler form is made on a card divided into forty-nine squares. These are numbered, and "ladders" drawn with Indian ink, while snakes cut out of gilt paper are pasted on.

3. *Card Ludo* (Fig. 36)

The "route" in this game is made of gummed-paper spots, with a house drawn on the board as a goal. Between the two players is a pile of cards, on each of which is an order, "Move up 2," "Go back 3," etc. Each child shows a card in turn,

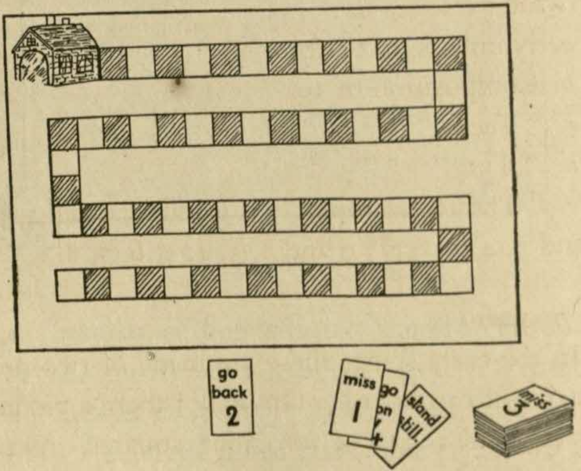


FIG. 36

and follows the instructions, the first to reach home winning.

GAMES FOR NUMBER COMBINATIONS

The all-important number bonds referred to in Chapter II, though taught in mental lessons, require constant practice, in some cases for years, before they become part of the child's mental make-up.

To assist in impressing these, we have a graded selection of jig-saws, lotto games, dominoes, and "snap" cards, which are specially constructed to provide exercises in:

a. Numbers up to 10.

b. Composition of 10.

c. "Teens."

d. "Tys."

e. "The 16 essentials," i.e. 6 and 5 ; 7 and 4, 5, 6 ; 8 and 3, 4, 5, 6, 7 ; 9 and 2, 3, 4, 5, 6, 7, 8.

1. *Jig-saws*

In the early stages these are made of two 9-inch squares of cardboard. On one of them a picture is pasted, and then cut into nine squares. On the back of each of these pieces a question is written. On the lower card we draw nine corresponding squares, and write in each of these the answer to the question on the picture piece.

From the very beginning we insist that, as this is a number exercise, the picture pieces must always be turned *face downwards* on the desk before the work begins. As each answer is found, the piece is put in place, and when all are used, they are reversed. If the answers are correct, the picture is formed properly; if not, the child finds out which piece is wrong. The exercise is completed by the child taking each piece in turn, and writing down question and answer.

Each puzzle has its own envelope, which is numbered. The same number appears on the back of the whole card, and on each puzzle piece, so that if any slip out, they can be replaced quickly and easily.

The early jig-saws are used as exercises for an individual child, and are graded as follows (Fig. 37):

1. Any nine of the figures 1 to 10, matched by the number pictures, also the reverse process.
2. Two numbers taken from between 1 and 5, added together in picture form.
3. Two figures between 1 and 5 added together.
4. "Picture 10" and one or other unit added, matched by the correct figures.
5. Composition of 10.
6. Simple questions on these combinations.

As the children *must* work their puzzles from the number side, and the picture is only to aid self-correction, it is essential that there shall be no two answers alike in the same puzzle. Although it is good for a child to know that 8 – 2, 4 and 2, and 10 – 4 are all answered by a card bearing "6," it is impossible for him to know where to put the "6" unless he looks at the picture side; and once he is allowed to do this, the exercise loses its number

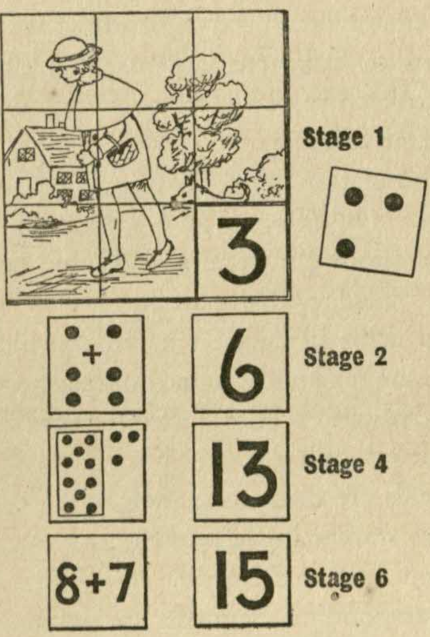


FIG. 37

value. So we select one illustration of a number for each puzzle, and rely for our variety on the number of different puzzles we can provide.

STAGES 2 AND 3

When nine pieces become too few, we make the puzzles more elaborate, and as more pieces are difficult to keep in place, we have devised a puzzle with a frame (Fig. 38).

The foundation card is about 9½ inches by 6½ inches. On this we glue a picture, leaving a margin of about ¾ inch all round, glue being more lasting at the edges than paste.

With a razor blade we cut out the picture, and then glue the remaining frame on to a sheet of white paper. Ordinary school drawing paper is suitable, as it is fairly tough.

Diagonals are then drawn across the back of the picture, as shown in the sketch, and questions are written on each piece *before the picture is cut up.* Then corresponding diagonals are drawn across the inside of the frame and the answers to the questions written in the spaces.

When doing this, we found that it was not always easy to remember that, when completed, the picture would be reversed, and thus answers were sometimes written in the wrong spaces. To prevent this, we found it useful to place the frame and reversed picture as shown in the diagram, and to fill in two adjacent sides first. By working away from these, to left and right respectively, no mistakes occur.

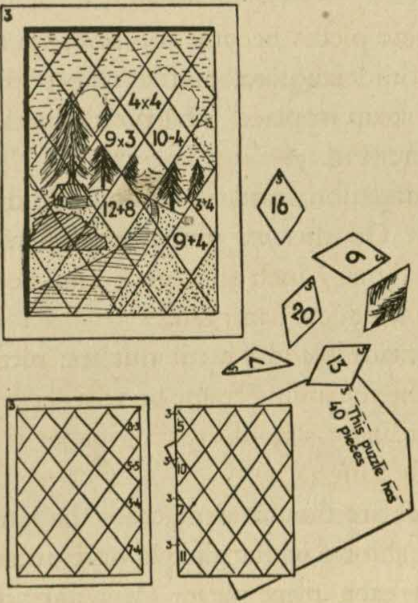


FIG. 38

Since the majority of the pieces are like diamonds, lazy folk can get no help from the shape of any particular portion. The sunken surface of the drawing paper keeps the puzzle pieces in position, and very few are swept to the floor by sleeves.

The questions on these pieces are made as easy or as difficult as required. They may include number combinations and any of the " tables " which have been taken.

As before, the frame, envelope, and pieces are all numbered, in case of loss. The same number written small at the top of each puzzle piece helps a child to place it the right way up. A note on the envelope—" This puzzle has 24 pieces " —helps him to know if it is complete. If not, the shortage can be reported at once, and *immediate* search for the missing piece usually meets with success.

These jig-saws, as pieces of self-corrective apparatus, are popular with teachers and children alike.

2. *Lotto*

In the illustration (Plate XI), five children may be seen playing lotto with simple home-made apparatus.

Each of the four players has a card of nine pictures (The " Look and Learn " series of 288 pictures, sold by the sixpenny stores, is an excellent source of supply for these pictures), and although the same picture may appear on each card, there is a difference in the order, so that each child must search his own card for the answer. The fifth child has a box of loose pictures which are the duplicates of those on the cards, and she turns them up in order, saying "Who has a teddy-bear?" The child who first answers "I have" receives the picture, which he places on the similar one on his card. The first to fill his card wins, and calls the cards for the next game.

With a little experience the children become very quick at this recognition of pictures, and are then ready for the more advanced forms of the game, which incorporate practice in number bonds, etc., in the following stages:

a. Recognition of Number Pictures

These cards provide simple illustrations in number picture form, e.g. 4 balloons, 3 cherries,

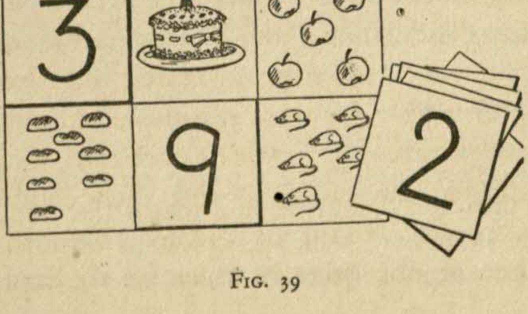


Fig. 39

etc., are drawn on the card, and the child calls out the figure which corresponds (Fig. 39).

b. Composition of Numbers to 5

This is taken in two ways. The first cards have the analysis of the number, e.g. 3 and 1, and the children call out the answer, 4, while the cards of the second set bear the numbers, and the children call out the component parts.

c. Composition of 10

d. "Teens"

Practice is useful in each way, some cards bearing 10 and 2, 10 and 5, etc., to which the children call 12 or 15, and the reverse process, as in *b* and *c*.

e. "*Tys*," which are really the 10 times table, and into which the × sign is introduced.

f. "16 *essentials*," as used in the jig-saw puzzles.

g. Tables, as learnt.

h. Composition of 15.

There is practically no end to the variations which can be introduced, and we find that if the cards are made of cardboard which is coloured on one side and white on the other, it is useful to have the answer written on the latter side. The child who is calling the question shows the coloured side to the players, but has the answer in view himself, so that there is no possibility of a wrong answer being passed.

The teacher will also find that to put up number charts on the classroom walls while number games are in progress is profitable.

3. *Dominoes*

The ramifications of dominoes are even greater than those of lotto, and this game is equally fascinating either as an individual occupation or as a group game.

The very early stages of picture and colour dominoes were described in Chapter III. These are followed by :

a. Recognition of Number Pictures to 5

These dominoes are of cardboard or plywood, 2½ inches by 1½ inches. On either end is a number picture made either of painted or gummed-paper spots.

The game starts by sharing the dominoes. The children soon recognise the " starting " card, which is marked with a star, and after this has been put out, the others play round in turn, matching the numbers.

b. Number Pictures and Figures to 5

In this set the starting card is marked as before, but now *picture* 3 must be matched by *figure* 3, and so on until the dominoes are exhausted.

c. Composition of Numbers up to 5

These cards provide early practice in composition, and the game proceeds by matching "2 and 1" with "3," etc.

Other variations follow, as in lotto and jig-saws, and the piece of self-corrective apparatus shown in

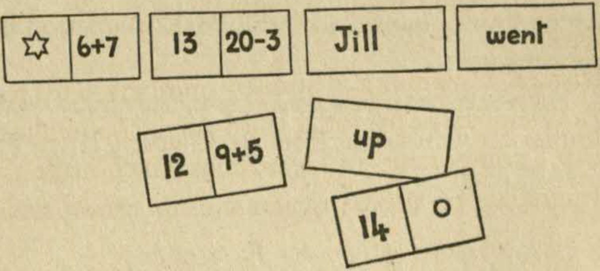


FIG. 40

Fig. 40 is a great favourite. It is known as "RHYMINOES."

Two children play the game, and having found the first card (marked with a star), Mary reads "6 and 7," to which Derek produces the card bearing "13." So they go on, until the last card (marked with a spot) is in place. Then they turn them over, and there on the desk is the rhyme " Jack and Jill went up the hill, to fetch a pail of water." The fact that the words are in the right order assures them that the answers to their sums are also right. So they turn them back and write out the questions and answers from the correctly placed dominoes.

4. *Snap*

This is a very real test of mental power and alertness. Plain cards, the size of the largest visiting card, are bought in packets from a printing firm, and a set of rubber number stamps will enable a teacher to make many variations in a very short time.

Besides " snapping " similar numbers and pictures as suggested for lotto, third-stage children may " snap " components of 10, pennies which make 1*s*., or fragments of any particular multiplication table.

CHAPTER XI

FRACTIONS AND PATTERNS

"Fractions" seems a startling heading in connection with work for infants; but when a child cuts an apple in two and gives "half" to his brother, or divides his orange and shares the "quarters" among his playmates, he is already using the vocabulary of "Fractions," and is ready to deal with pieces of apparatus as he does with his apple and his orange. It is along such lines that we proceed.

The children are supplied with circles of coloured paper, and begin by cutting these into halves. Then, by changing pieces, whole cakes of differently coloured halves are formed, the children finding always that any two of the pieces make a whole cake.

Some of the halves are then cut into two to give four quarters, with which the children work, first combining their pieces in as many ways as they can to make whole cakes, and then, beginning with whole cakes, taking away certain pieces and finding what remains.

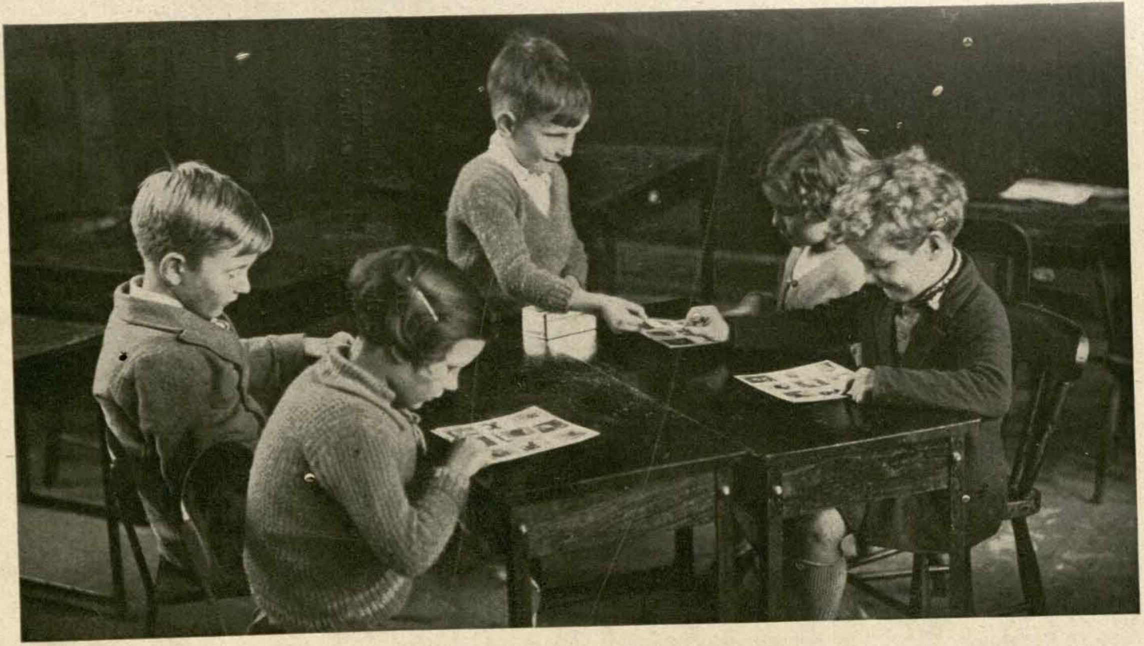


PLATE XI
Playing Picture Lotto. " Who has the Teddy bear ?" " I have."

PLATE XII

Fractions. Making whole cakes from the coloured segments lying in the tray. The children learn to use ½'s and ¼'s at the same time as they spend ½*d.*'s and ¼*d.*'s

Finally, some of the quarters are halved and the earlier exercises are repeated with the new range of pieces.

When, through these experimental exercises, the children have been introduced to the fractions, they continue work with cardboard circles, as in the illustration. These fraction pieces are kept in a wooden tray, and each value has its particular colour. A typical card of exercises at this stage is:

1. Make a cake, using red, green, and black pieces.
2. How much is red?
3. How many pieces are green?
4. Take away the black part. How much is left?

To help the children to illustrate their statements each has a small circle of cardboard, with a hole in the centre, and marks on the circumference to show $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$. With the aid of this, the child draws the circle, marks it as required, colours it with his crayons, and adds the statement and conclusion beneath it.

STAGE 3

The children of Stage 3 pass to further work with circles.

Beginning with exercises such as those used in Stage 2, they express their answers, not only in the numbers of pieces, but also as fractions, e.g. " I had

1 green piece, 2 brown, and 1 red. The green was ½, the red was ¼, and the browns were $\frac{2}{8}$. The browns filled as much space as the red, so $\frac{2}{8}$ is as much as ¼."

These are followed by simple problems based on ½ and ¼ particularly, as training for the ½*d.* and ¼*d.* with which the child will soon meet. Such cards are:

1. I ate ½ a cake every day for a week. How many cakes have I eaten?

2. A teacher gave 16 children ¼ of an apple each. How many apples were cut up?

PATTERNS

From fractions it is but a step to "patterns"—the children's name for their first lessons in geometry.

The apparatus for this group consists of trays of small wooden shapes, triangles, squares, and oblongs. These pieces are made from sheets of thin plywood, painted with spirit stain, *before it is cut up.* We find that this is much less trouble than cutting out the pieces and then staining them. Among the pieces are:

1-inch squares; oblongs, 2 inches by 1 inch; equilateral triangles with 2-inch sides.

Then we add:

Right-angled triangles which are half the square;

others which are half the oblong; 1-inch equilateral triangle which is $\frac{1}{4}$ of the larger one.

Although *we* use wood, these shapes could quite well be made of cardboard, the difference being in length of life.

The first exercise gives practice in recognition of shapes. The children are supplied with a hectographed sheet of drawings of the various wooden pieces in the tray. There may be several of the same shape, but at different angles; at first the children are puzzled by the varying attitudes, but they soon become quick at finding and covering each drawing with the correct piece. The outlines are then coloured to match the wood, after which the children group the patterns according to the number of sides in each.

The next step is to find out which shapes can be combined to make one of the others, e.g. two squares to make an oblong, or two triangles to make a square.

After this the names of the various shapes are taught, and the children find examples around them, such as the classroom floor, a desk, or a passage.

A series of exercises follows, a typical one being:

1. Measure the side of a red square.

2. Make on your desk a big square with 3 small squares in each side.

3. How long is each side of the new square?

4. Draw it.

5. How many little squares will fill the shape you have drawn?

When the children have learnt that the small wooden shape—red in our case—is known as a "square inch," they proceed to use it to find the area of plywood letters such as capitals E, H, L, T, and shapes as shown in Fig. 41. These are made of wood, an inch wide, and are always an exact number of inches in length.

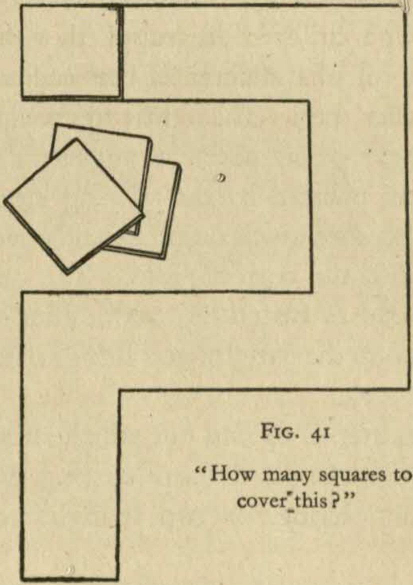


FIG. 41

"How many squares to cover this?"

The wooden " square-inch " units are fitted on to the selected shape, after which the figure is drawn and the children state the number of " square inches " used.

There is no mention of the term " area " : the children speak of the " space occupied " ; but we feel that throughout these exercises they are having experience of the difference between inches and square inches, between length and area.

CHAPTER XII

WORK RECORDS AND TRAYS

THE invariable query of every visitor who sees our classes at work is, "How do you know what each child has done?" The answer is seen in the work paper which every child, from the earliest stage, produces at the end of each lesson.

The very earliest records are pictorial in form, as we have said in an earlier chapter.

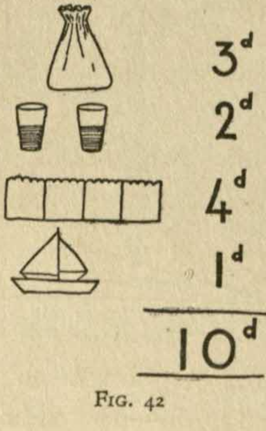


FIG. 42

The youngest "shopper," having spent his 10 pennies, helps himself to a sheet of paper and a coloured pencil and draws both his purchases and the pennies he spent on each.

Fig. 42 shows that George went first to the "Sweet stall," where he spent 3*d.*; next to the "Milk-bar," where he spent 2*d.*; a third purchase was fourpennyworth of ribbon, and his last penny bought a boat.

An interesting sidelight showed itself after a few months' work. One noticed how the brighter children tended to make their 10 pennies last for more and more transactions, and instead of spending 4*d.*, or even 3*d.*, at one stall, they made six or seven purchases, none of which exceeded 2*d.* The teacher then suggested that they might make fewer purchases, record what they had spent, and also how much they had left. So as well as having experience in simple addition to 10, they began subtraction by complementary addition—just as all shopkeepers give their change.

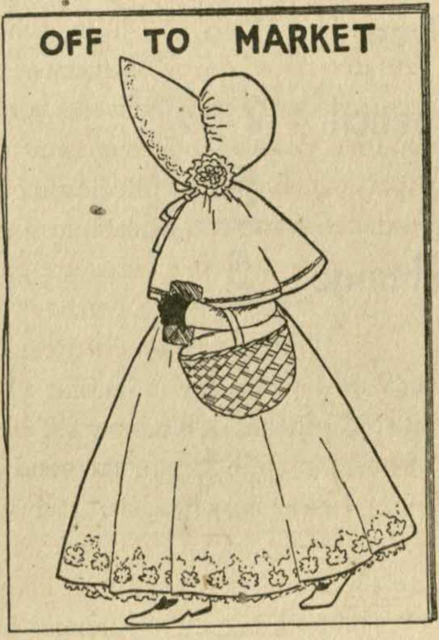


Fig. 43

When the children begin reading, they find at each stall a stock list with simple illustrations and the word for each article. So the six-year-old child makes a simple shopping book, as shown in Fig. 43, and a page reads as Fig. 44.

house 2 oo

tree 1 o

pencil 2 oo

5

change 5

Fig. 44

Similarly, with the measuring exercises, etc., John, who is 6 years and 8 months, makes very little use of drawing in recording his work, and the following are extracts from his sheets :

22.9.38

"I sold 9 inches of lace, and 3 inches and 2 inches. It made 14 inches.

I sold 4 inches of lace 3 times. It made 12 inches.

I cut off 11 inches of lace and gave 7 inches to Bob. I have 4 inches left."

4.10.38

"The pink bag A is 3 ounces.

The yellow bag A is 1 ounce.

The blue bag C weighs the same as pink bag A and yellow bag A.

The blue bag C weighs 4 ounces."

These sheets are kept in folders, the covers of which are varied according to the inclination of the owner (or the owner's teacher). The folders seen in the photograph (Plate XIV) are made of a piece of stiff wallpaper, with a flap turned in on either side, top and bottom, so that the sheets can be put in easily and will not fall out every time the whole is touched.

The cover is decorated with cut paper illustrations of scales, measures, and a clock face, or is painted in Art lesson, as in Fig. 45.

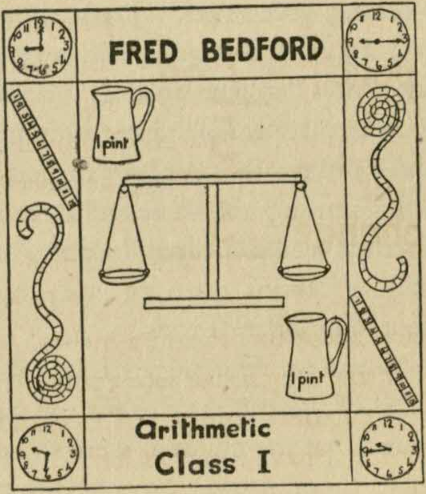


Fig. 45

Trays

When the children began to record experiments in the basic operations, we found that " Trays " were exceedingly useful.

These trays are box lids, in which are a number of small objects, such as beads, buttons, or pennies, and a number of small receptacles into which they can be placed. We usually use the base of a cheese box as a large container for the loose material, as it is deep enough to prevent loss and yet wide enough to make handling easy. The receptacles into which the beans, buttons, etc., are to be placed are the trays of tiny boxes, blocks in which stand wooden rods, or cardboard figures cut from fashion plates.

The illustration (Plate XIII) shows two children working with trays. Joyce slips 18 rings on one rod, 19 on the second, and 7 on the third. Then she writes "18 and 19 and 7 make 44." Betty began with 40 pennies. She gave 17 to one of her "dolls" and 14 to another. She writes 40 – 17 – 14 = 9.

By putting the same number into each box the children make "times" sums, or they can begin with a certain quantity and divide it between a chosen number of rods.

When we first began trays, we tried to supply cards of suggested sums for use with them. But we found that the children were so anxious to do what they thought we expected that they failed to appreciate that they could use the material to make exercises for themselves. So now they are allowed to experiment as they wish, the only condition being that they must afterwards write down *what they did and the result obtained.*

During the third stage we find that the practical experiences hitherto gained by the children, combined with their constant mental practice, so develop their number consciousness that a very slight visual stimulus will set their mental machinery in motion. Gradually they feel far less need of actual apparatus, and as the teacher moves round the class, she will find many children with answers on their papers which are quite correct, but which she knows have been obtained by mental processes only. When such a stage is reached, we know that the child has indeed a real knowledge of number, and are assured that he is ready for the more orthodox methods of stating his results, which he will find developed in the *Rightway Arithmetic Series*, Books 1 and 2 (published by University of London Press Ltd.).

CHAPTER XIII

CLASS ARRANGEMENT

The activities in which the children engage are so varied that we find it necessary to divide the classes into groups.

The occupations of the Reception Class provide opportunities for those activities which are the basis of the practical work of the later stages, but when the children leave this class, there has to be a regular rota.

Our classes of forty-eight children are divided into six groups of eight, and one of these works at a particular activity throughout a Number period. Each of these activities is attractive, but as a child needs the experience of all, he must not stay at one to the exclusion of others, but must change in an agreed order.

To ensure this, we have arranged a system of rota, which is worked both in the second and third stages of the scheme.

Rota Cards and Badges

When the groups are made up, each has its own badge.

These are made in Handwork lessons by the children and are very simple. The base is a square or circle of coloured cardboard, and on it is a design which varies with the class.

Our children chose coloured patterns for one class, woolly pompoms of various colours for another, toys for the next, and animals for the top class.

The children who wanted patterns cut out red circles, blue triangles, green stars, yellow ovals, purple rings, and black crescents from gummed paper and stuck them on their square cards.

The pompoms were made like woolly balls, by winding wool round 1-inch-wide strips of cardboard, three pompoms of one colour being allowed to each badge.

The toys and animals were printed with the rubber stamps taken from nursery printing sets. The outlines were painted by the children, and then the badges were fastened on with small gilt safety-pins.

On the wall hangs a rota card, divided as shown in Fig. 46. (The headings vary as the teacher wishes.)

In each of the squares below "Day" is stitched the lower half of a press-stud, which cannot tear off, because before the sewing began, a strip of tape was glued behind the card. The upper half of the press-stud is sewn to a circle of cardboard, on which the word "TO-DAY" is printed, thus making an indicator which can be moved to any of the studs.

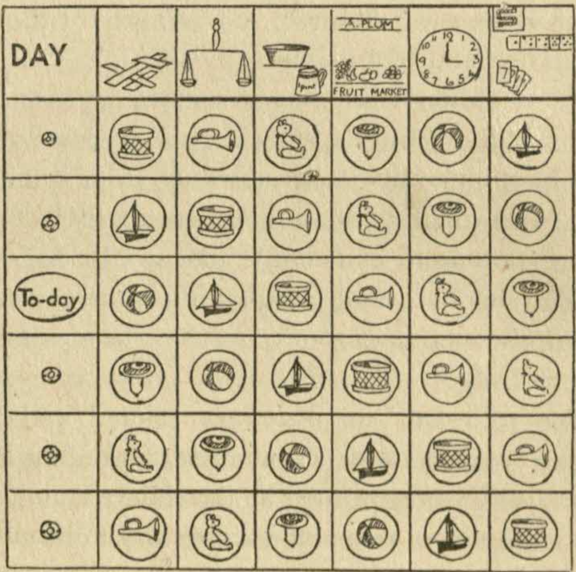


FIG. 46

At the beginning of a Number period, the children find the square in which their badge appears, read the head of the column, and proceed with that piece of work.

In order to allow groups of eight to divide into two fours if the teacher so wishes, we provide two occupations for each section. Those of the second stage are:

1. Sweet Shop and Milk-bar.
2. Measuring Cords and Ribbon Shop.
3. Games—Lotto, Tops, and Dominoes.
4. Jig-saws—2 stages.
5. Clocks and Patterns.
6. Trays and Floor Games.

The third-stage divisions are:

1. Weighing and Capacity.
2. Shopping at two types of shop.
3. Measuring Objects and Measuring Problems.
4. Patterns and Fractions.
5. Money Cards and Buses.
6. Trays and Clocks,

with a selection of games to be taken as and when the activity for the day is completed.

The children work at an occupation for two successive lessons, so that they may have an opportunity to overcome any initial difficulty in handling the material and be able to derive real benefit from their work. On the third day they change with the other four in their group, and on the fifth day the indicator moves on, and they change for the first of two days' experience with entirely new material.

Visitors sometimes wonder whether the children may become too accustomed to any particular activity, but as in a normal term they only work at any particular section twice, it is easy to see that the time is too short to allow of such a possibility. Moreover, by the time a child comes to any section for the second time, his experience has so widened that he probably uses the material in an entirely different way from that in which he employed it the first time.

DESK FORMATIONS

Freedom of movement and space between the groups is very desirable, so during a Number period one of our classrooms resembles that shown in Fig. 47.

We found three ways of achieving this arrangement. The first is by keeping a special room for number and allowing the classes to use it in turn; the second is by keeping the apparatus in a normally occupied classroom and moving the classes about; and the third is to rearrange the furniture of the room for the Number period.

The first method is, of course, the ideal, the second is a useful one, and the third, in the majority of schools, is the most likely.

In these days, few schools have a spare room. If, however, a room has been devoted to

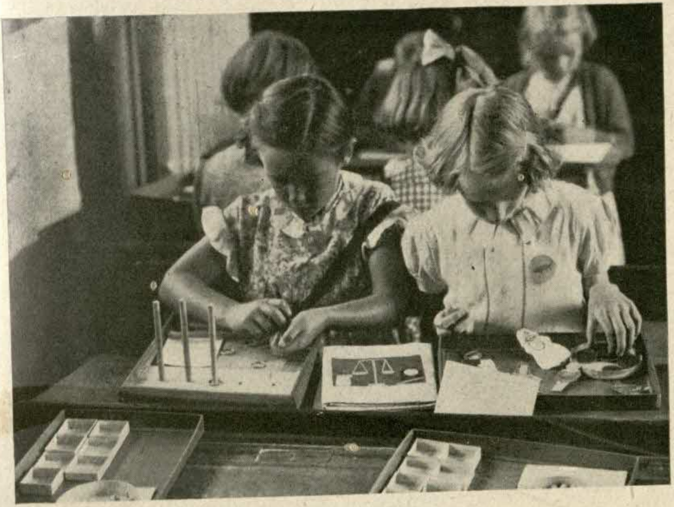


PLATE XIII

Trays. With these the children make up their own sums in the four processes, using as many of the rods or small containers as they wish.

PLATE XIV

In these folders the work papers are kept. The covers are decorated with cut-paper designs, and the end flaps fold over to make two pockets

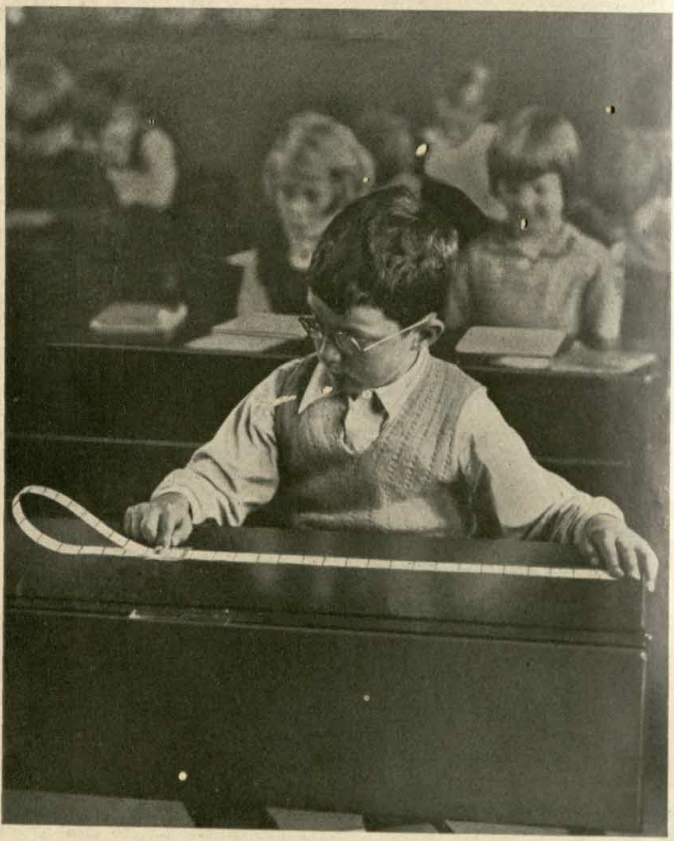


PLATE XV

" 19 and 3 " . . . Dennis has found 19 on one end of his tape measure and, by adding on 3 from the other end, is finding the answer to his sum.

Practical Number, there is no doubt that economy in time and material can be effected.

Much of the apparatus used by Stages 2 and 3 is the same. Often one class contains children of such varying attainments that they need a choice of material from both sections. In any case, the difference between the stages is mainly a difference in the way the material is used, so if several classes can use one room and one set of apparatus, costs and preparatory labour are at once reduced.

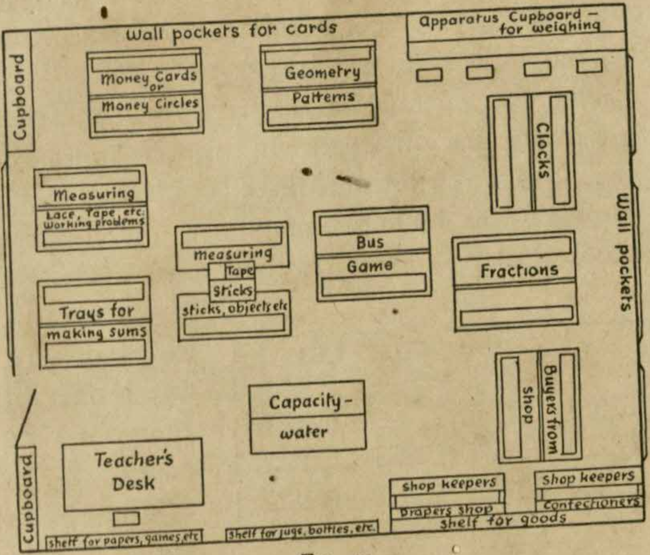


FIG. 47

If no room can be spared always, it may be possible to arrange that classes may use the same apparatus by moving into each other's rooms for certain lessons—Reading or Music, for example—while another class has Number. This has been tried and found practicable, but it certainly calls for "give and take" between the teachers concerned, and even children have been known to resent the occupation of their desks by others.

Sometimes the only alternative is for the teacher to rearrange her furniture. In this case we find it possible to turn a normally-placed class into a useful Number formation in two minutes. A teacher in a school working on this method turns a class of children of 5½ years of age, in this time, by the following plan.

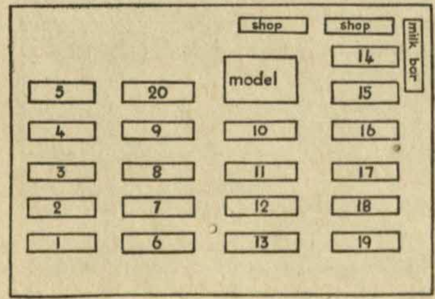


Fig. 48

The desks are, as a rule, arranged as shown in Fig. 48, the little square representing the table on which stands the class model, and this, of course, cannot be moved.

On each desk is a little cardboard square, bearing the figure shown in the diagram. When it is time for a Number period, the teacher calls out these figures in a definite order, and as she says each one, the two children in that desk pull it back,. push it forward, or turn it, till it is in the position shown in Fig. 49. The children then look at their rota card, fetch the required work from the cupboard, and proceed.

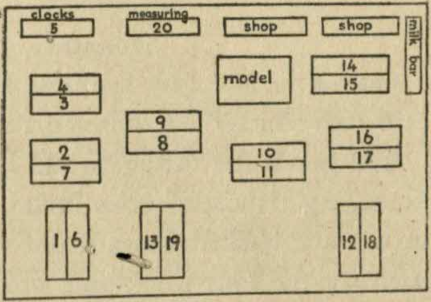


Fig. 49

The order in which the Number class is formed is :

5	—	20
1	6	13
19	18	2
7	11	12
3	8	15
17	—	—

The order for return to normal at the close of the lesson is :

3	15	17
18	8	11
12	7	2
19	6	13
5	1	20

The desks numbered 5 and 20 become the " Clock " group and the measuring group respectively, while the three unnumbered desks against the wall are the two shops and the " Milk-bar."

STORAGE

One of the attractive features of this scheme is the ease with which the required material can be stored.

The goods for the shops can be packed away in boxes, e.g. Hudson's soap boxes, which when not in use are stacked beneath the shops. The trays used for the four rules, and which hold fractions, bus tickets, and patterns, stand one above the other in a corner of the shelf. Clocks, stamp cards, money cards, game envelopes, and the exercises framed round the other activities are housed in pockets hung on the walls or behind the desks.

In fact, this method needs less space than that previously required for the many sets of sum cards used in " Individual " work by Number classes, for instead of the 50 cards which every step demanded, half of the exercises are constructed by the children themselves, and the remainder are provided by half a dozen examples for each stage.

CHAPTER XIV

RESULTS

The concluding chapters of the book are in sight, and still we have made no mention of "results." Are there any?

Most certainly there are. At intervals throughout the description of the scheme, evidence of such has appeared in the extracts from the work sheets, but by the time the child is ready for promotion to the Junior School, these results are, to us, so satisfactory in many ways, that it seems worth while to classify them.

First, there is the children's own attitude to the subject. It is not long since an experienced Probation Officer gave it as his considered opinion that a dislike of Arithmetic was a fruitful cause of truancy, and even if infants have not felt quite so strongly on the subject, it is certain that many children have considered it the bugbear of their school lives.

In our schools, we find that the adoption of Practical Number as outlined in this scheme has revolutionised this attitude among the children.

They no longer fear it, but it is easily the most popular among the academic subjects. Even the dullest child can find something he can *do* and enjoy, and at any given moment each one is exercising his capabilities to their fullest extent. Capabilities may—and do—vary, but every fresh experience adds to mental development. The compulsion to learn is now exercised from within by the child himself, instead of from without by the teacher; and surely that is a result worth consideration.

Secondly, as a means of promoting general intelligence, this method assuredly produces results. In school we have noticed that in such matters as milk and biscuit money, Poppy Day collections, and photograph payments, the children are vastly more capable than they were prior to the introduction of this Number scheme; and the parents have commented again and again on the intelligent way in which their children now shop, take the milk, weigh out their groceries, and do the hundred and one little mathematical operations which come in the course of a housewife's day. And since our aim is to make Arithmetic a tool which is of use in the hands of the children when they begin their working lives, it seems as though we are achieving some success.

But useful as these results are, we have still to consider results from an examination point of view. Regarded from this angle, are there any?

At first glance the child does not seem to have accomplished so much as he did along earlier lines. He does not show any sums in "Hundreds, tens, and units," the number of "tables" he learns is smaller, and he does not work in "£ *s. d.*"

But with a less extensive syllabus, his knowledge is very much deeper and clearer than before. He really understands the significance of the figures with which he is dealing, and can pass from one process to another without confusion.

It does take time for the teacher to realise the full value of the change. We feel that the position is well illustrated by the teacher of one of our Promotion classes. In previous days she had obtained excellent examination papers in Arithmetic, and we found her feeling that because the children going from her under the new method did not produce the same type of paper, they were less advanced.

Being, personally, very satisfied with the progress of the children, they were re-tested for the encouragement of their teacher, and we found that they could speedily and accurately add a series of tens and units, could subtract using any of the number bonds to 20, understood and could use the processes of multiplication and division, though they did not use these terms; furthermore, they could tell us the measures used by the various tradesmen, could conduct small transactions with them and give the correct change, and had a working knowledge of time.

Need more be asked from any infant class? We admit that those children did not put down their results in the orthodox form. The following are typical extracts from their work sheets:

6.9.38

“ I bought	*s.*	*d.*
Birthday cake	1	0
Block of chocolate		6
3 cakes		3
loaf		2
I spent	1	11

I have 7*d.* change out of 2*s.* 6*d.*

27.9.38

“ 4 shapes balance 22 peas.

18 beans weighed 1 ounce. There were 10 in ½ ounce. That's because some were little beans.

3 spoonfuls of sago make 1 ounce. I put 4 spoonfuls in a pudding, so I can make 6 puddings with ½ a pound.

5.10.38
"Two milk bottles fill the small kettle.
1 pint fills the tea-pot once.
3 school milk bottles make a pint.
I can fill three cups from the pint measure.

11.10.38
"Oranges are 3 for 2*d*. I can buy a dozen for 8*d*.
I can get 21 for 1*s*. 2*d*. I got 15 oranges out of 2*s*. 6*d*. I had 1*s*. 8*d*. change."

We feel that, given such results, which show that the child has a real grasp of number, it may be left to the Junior School to show him the conventional methods of Arithmetic, and that the comprehension of principles and the power to attack problems, shown in the above papers, is more than adequate compensation for the loss of the orthodox "six sums."

And this is granted by visitors who pass round the classes and speak to the children, and find again and again that, though the standard of attainment varies from child to child, each one of them can give a reasonable account of what he is doing. It is results such as these which convince us that our faith in the method is justified, for it *does* produce results.

CHAPTER XV

HINTS ON TRANSITION

A FEW practical hints may be of use to any teacher who contemplates the adoption of "Arithmetic in Action" as a school method.

The most important maxim is:

HURRY SLOWLY

The methods previously in use are not wrong. They have achieved results in the past, and should not be at once superseded. Begin with a little of the new method at a time, till, by degrees, a class which has known nothing but these new ways works through the school. But do not let a class which is unused to these ways be overwhelmed by a mass of strange approaches.

We began with the top class, for two reasons. First, because we felt that, as both teacher and class are experimenting, it is easiest to begin with children who are so used to school routine that they can co-operate readily; and secondly, because we find that lower classes are more willing to adopt methods in use in higher classes than are the "Sevens" to "copy from the Babies."

It is impossible to dogmatise as to the way of transition from any previous method to the practical approach. We can only say how we accomplished it, and leave others to follow, and possibly improve on, our way.

We decided to introduce one activity at a time, as a class lesson, and began with measuring, as described in Chapter IV, with the teacher who marked out her shoe length on newspaper strips. Following this, one group of children experimented in this activity under the teacher's direction, while the remainder of the class continued their "Individual" work as before. During the next Number period a second group had practical experience in the same activity, and this continued until every child had had a turn.

During this time, the stock of the "Draper's" shop had been in preparation in Handwork lessons, so that the children were ready for a class lesson on this second activity. Following this, one group shopped, a second measured, and the rest worked as before. When this cycle was completed, the other activities were introduced in turn in the same way—Weighing, Money Cards, Games, and Capacity.

Once the six groups are working in this way, it is possible to allow them to work on until the explanation of a new process, or of a new phase, e.g. Tape-measure, becomes necessary, when another class lesson is given.

TAPE-MEASURE

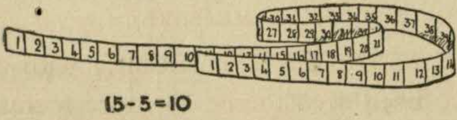
This is most useful when dealing with children who have been accustomed to more formal arithmetic, as well as those who want some form of self-correction. Such exercises as those seen in Fig. 50 may be checked readily by this means.

At first, any ordinary tape-measure will do, so long as it is numbered on both sides, and the numbering begins at either end. The children call this tape "magic," because it sometimes knows the answers to their sums better than they do, and this is how it works.

If a child wishes to find the total length of 7 inches, 9 inches, and 13 inches, she begins, at one end of the tape, with 7 inches. Then, taking up the other end, she finds 9 inches on that and bends it back so that the 9-inch piece continues from the original 7 inches, and reaches to 16 inches. Then, using the far end again, she finds 13 inches, and bending that back to continue from the 16 inches, reaches a total of 29 inches.

As seen in the illustration (Plate XV), 5 inches taken from 15 inches leaves 10 inches.

"Take 9 four times" is easy, as 9 inches is measured once, folded over four times, and there is the answer. Similarly, "24 divided by 4" means folding a strip of 24 inches into four pieces, or if a child wants to know "How many 6's in 36?" all she has to do is to find 6 inches and fold it back on itself until she reaches 36.



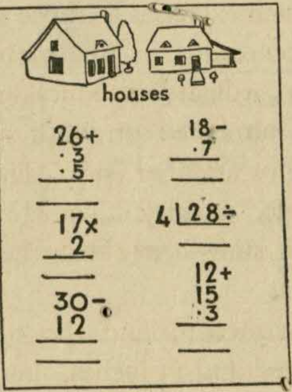
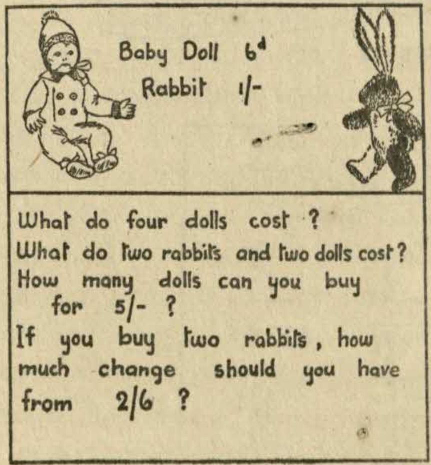


FIG. 50

Children used to formal Arithmetic will need a measure showing more than the 60 inches supplied on an ordinary one. For these children we make long ones, quickly and easily, out of rolls of white adhesive tape stuck together. On either side we draw the inch lines with Indian ink and number them, being careful to begin at one end on one side, and the opposite end on the other. They are kept in the discarded boxes of type ribbons, begged from City friends.



What do four dolls cost ?
What do two rabbits and two dolls cost?
How many dolls can you buy for 5/- ?
If you buy two rabbits, how much change should you have from 2/6 ?

FIG. 51

Another exercise which helps to bridge the gulf between the previous formal and the present practical number is seen in Fig. 51, and a further extension of such exercises will be found in Book 1 of *Right-way Arithmetic Series* (published by the University of London Press, Ltd.).

Provision of material for children during the transition period does present certain difficulties, particularly when dealing with bright children who feel that they know 8 − 4 = 4, and do not require apparatus to prove it.

The duller children are, as a rule, thankful to have something which gives reality to a hitherto uncomprehended mass of figures, and they make rapid progress along these lines.

With the brighter children, a few questions such as the following—

How tall am I?
How long is a newspaper?
How heavy is this book?
How much water does this bucket hold?

soon effectively excite their curiosity, and they begin to comprehend that there is something more in Number than they have hitherto encountered in their "Sums."

Children of this type are always eager to try anything new, and in a short time they realise that rulers, scales, and weights, etc., are not playthings, but are part of "grown-up" life, and that exercises requiring their use are much more "alive" than sums which were mere manipulation of figures, and that they *do* require as much mental alertness.

GROUPING OF CHILDREN

The materials provided for each group can be utilised in so many ways that it does not become necessary to group the children according to their mental ability. If an "A" child is at the measuring table, he can construct for himself an elaborate series of exercises in the four basic operations from the same box of sticks from which a child of less mental ability is taking single ones for measuring. Each is able to find work which engages his powers to the fullest extent, and though the results are on a different level, they do afford to the individual child the satisfaction of having accomplished a piece of real work.

NOISE

Finally, may we add a word about the sound which this method produces. There is a noise as little feet cross and recross the room, and children exchange experiences with one another. Perhaps at first, when everything is new and promises fresh adventures, there may be a little more exuberance than the teacher is accustomed to, but it will not be because the children are not working, and as they settle down to the routine of work, the temporary excitement will pass and the teacher will realise that she need not mistake the hum of real work for disorder. A hive is never silent when the bees are working.

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